


Historical Review: Fast & micro Gas Chromatography

Dr. Ed Overton, Professor Emeritus

Department of Environmental Sciences

Louisiana State University School of the Coast & Environment

Presenter: John Crandall

First… about Ed

- Analytical-Environmental Chemistry – trace organic analyses using high resolution separation techniques and high resolution gas chromatography-mass spectrometry
- Environmental monitoring
- Environmental analyses and their associated data interpretation, management and presentation techniques
- Application of analytical techniques and chemical principles to emergency spill responses
- Chemical hazard evaluations and risk assessments
- Analytical instrument development for use with hazardous chemical spill incidents, ambient environmental monitoring, and monitoring in closed (indoor) environments
- Development of methods to detect, assess and mitigate environmental chemical hazards

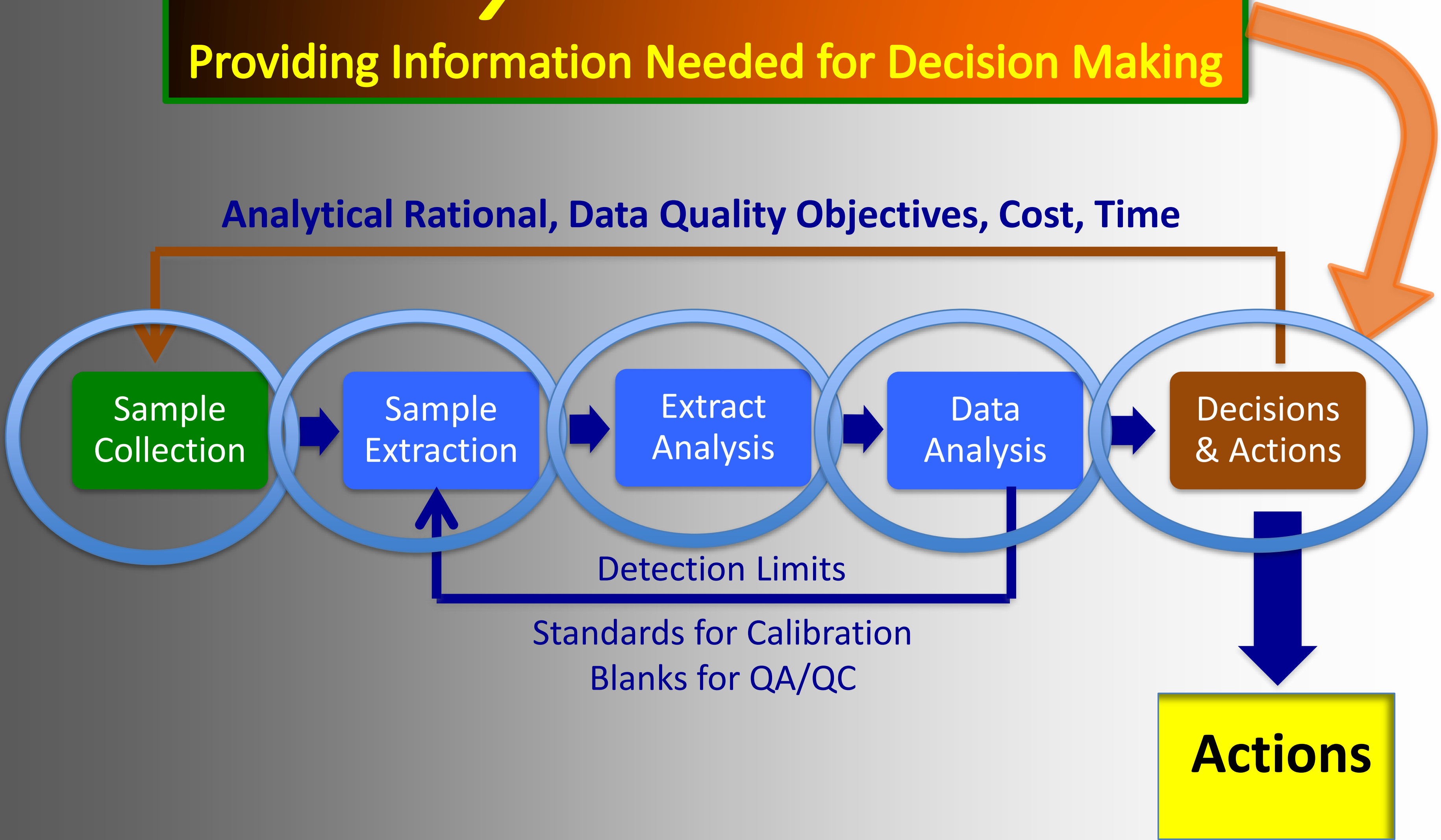
More Importantly

- **Because of his environmental measurement needs Ed has been…**
  - Vigorous supporter of Fast, micro and transportable gas chromatography
  - Inventor in pursuit of analytical problem solving
  - Team leader at LSU's School of the Coast & Environment
  - Leading participant in the IFPAC and ONSITE communities
  - Leading voice of reason regarding crude oil spills and their impact on the environment
  - And MOST importantly…

Educator and mentor inspiring others to join the field

Analytical Process

Providing Information Needed for Decision Making



Types of Air Pollution

Criteria Pollutants

Acid Rain

Oxidized organics (TO15)

Industrial Pollutants

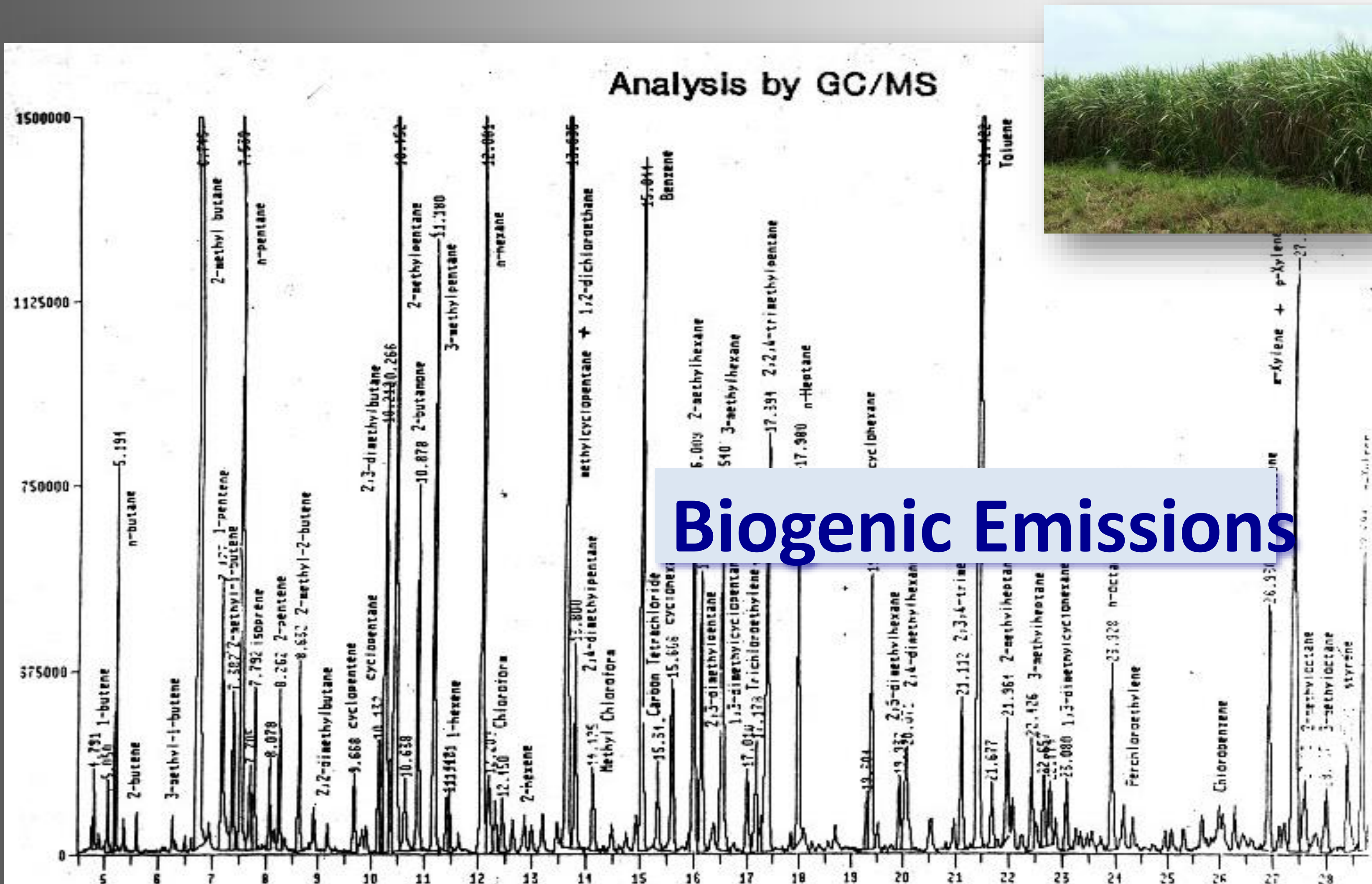
Ozone Precursors

Air Toxics (TO14)

Greenhouse Gases

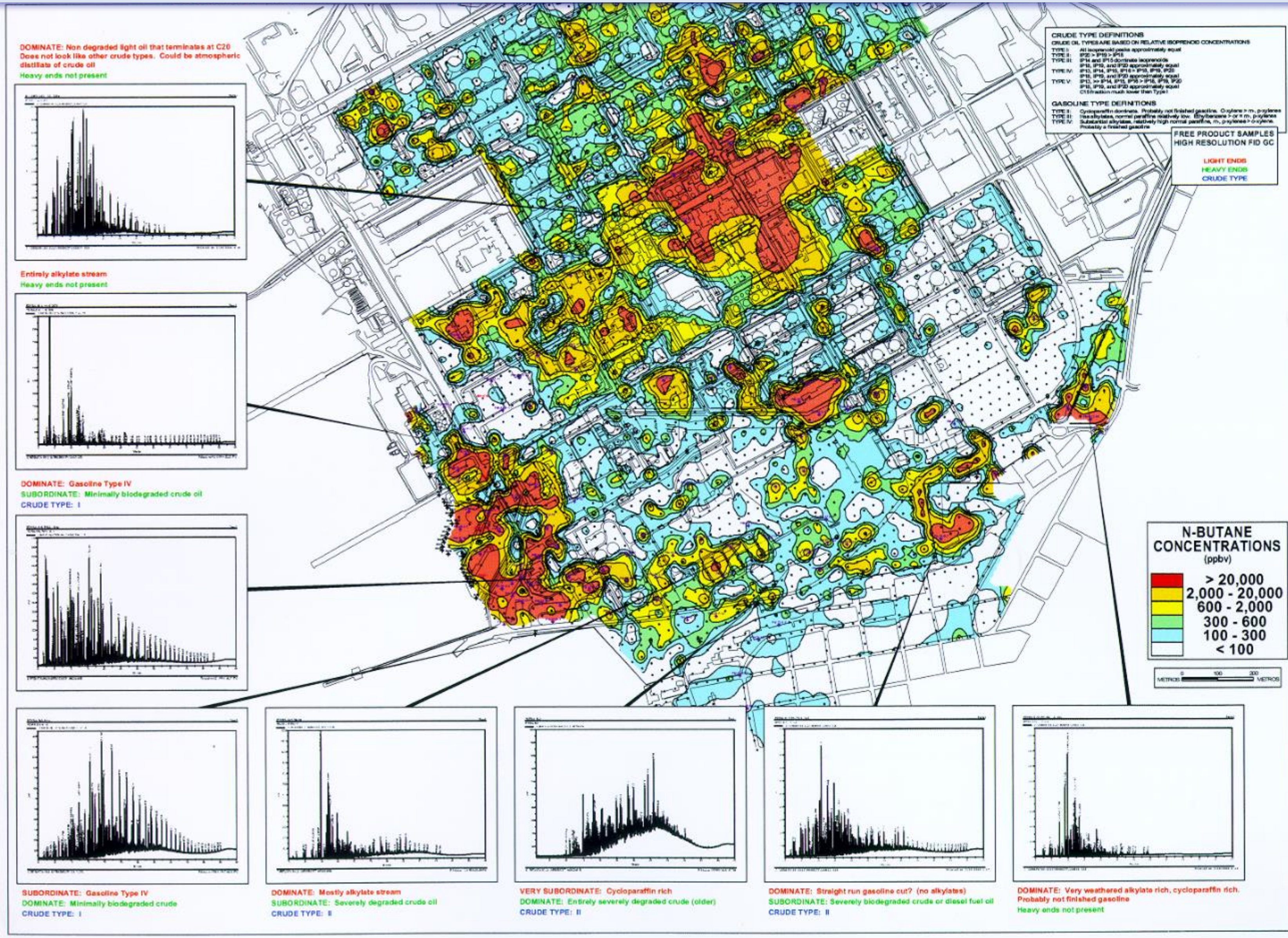
Indoor Air

GCMS Chromatogram of Rural Air Sample collected in the middle of a field



Biogenic Emissions

Refinery Site: GC Analysis of Selected Free Product Samples and Airborne Butane Conc.



Vapor trail

Elephants also possess one of the most well developed senses of smell in the animal kingdom. This keen **sense of smell** is used not only to **locate food and water sources but also for communication**. Elephants detect and process many chemical signals in a wide variety of smells throughout their environment. Sources of odors used in chemical **communication between elephants** include urine, feces, saliva, and secretions from the temporal gland.

TABLE 3. Distinctive volatiles in temporal gland emissions, breath, and urine of Asian elephants in the United States and India

	Acetone	Isoprene	Butanal	2-Butanone	2-Methyl-3-buten-2-ol	2,3-Butanediol	Dimethyl disulfide	4-Heptanone
PostM-TG	x							
PreM-TG	X	X	X	X				
PreM-TG[a]	X	X	X	X				
Skin-C	X							
PreM-B	x	X	X	X	X			
PreM-B[a]	x	X	X	X	x			
PostM-B	x							
PostM-B[a]	x							
Preg-B	x	X		x		X		
Preg-B[a]	x	X		x		X		
Preg-U	x			x			x	X
Preg-U[a]	x			x			x	X
Mahkna U	x			x			X	

[a]Control samples, U.S. studies [Rasmussen and Perrin, 1999].
X, high concentration; x, lower concentration; M-TG, musth temporal gland secretions; C, control; M-B, musth breath; Preg, pregnant; B, breath; U, urine.

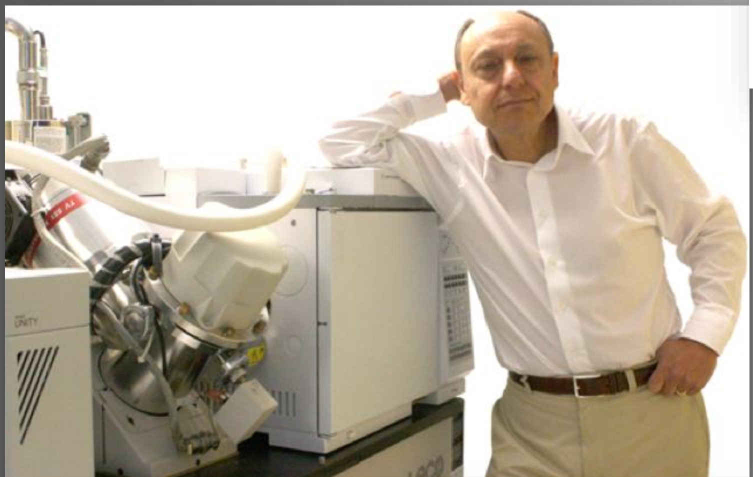
MENSSANA RESEARCH, INC.

HOME NEWS ABOUT SYSTEMS TEST CENTERS PUBLICATIONS PRODUCTS CAREERS C

BreathLink rapid point-of-care breath test for breast canc

Effect of influenza vaccination on oxidative stress products in breath

Michael Phillips[1,2,6], Renee N Cataneo[1], Anirudh Chaturvedi[1], Patrick J Danaher[3], Anantrai Devadiga[1], David A Legendre[4], Kim L Nail[4], Peter Schmitt[5] and James Wai[1]



Breathometer

DIAGNOSTICS

Point-of-care breath test for biomarkers of active pulmonary tuberculosis

Michael Phillips[a,b,*], Victoria Basa-Dalay[c], Jaime Blais[a], Graham Bothamley[d], Anirudh Chaturvedi[a], Kinjal D. Modi[h], Mauli Pandya[a], Maria Piedad R. Natividad[e], Urvish Patel[a], Nagsen N. Ramraje[f], Peter Schmitt[g], Zarir F. Udwadia[h]

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[b] Department of Medicine, New York Medical College, Valhalla, NY, USA
[c] Center for Tuberculosis Research, Angelo King Medical Research Center, De La Salle Health Sciences Institute, Cavite, Philippines
[d] Department of Respiratory Medicine, Homerton University Hospital NHS Foundation Trust, London E9 6SR, UK
[e] Center for Respiratory Medicine, The University of Santo Tomas Hospital (USTH), Espana Boulevard, Manila 1008, Philippines
[f] Sir J.J. Group of Hospitals, Byculla, Mumbai 400008, India
[g] Schmitt & Associates, 211 Warren St, Newark, NJ 07103, USA
[h] P.D. Hinduja National Hospital and Research Center, Veer Savarkar Marg, Mahim, Mumbai 400016, India

Prediction of breast cancer using volatile biomarkers in the breath

Michael Phillips[1,2], Renee N. Cataneo[1], Beth Ann Ditkoff[3], Peter Fisher[4], Joel Greenberg[1], Ratnasiri Gunawardena[5], C. Stephan Kwon[6], Olaf Tietje[7], and Cynthia Wong[2,5]

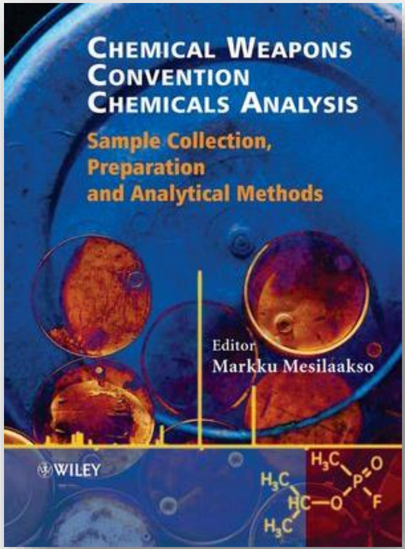
[1]*Menssana Research Inc., 1 Horizon Road, Suite 1415, Fort Lee, NJ 07024, USA;* [2]*Department of Medicine, New York Medical College, Valhalla, NY USA;* [3]*Department of Surgery, Columbia University Medical Center, New York, NY 10032, USA;* [4]*Department of Pathology, Columbia University Medical Center, New York, NY 10032, USA;* [5]*Department of Medicine, Saint Vincents Catholic Medical Centers of New York, Staten Island Region, New York USA;* [6]*Department of Laboratory Medicine, Saint Vincents Catholic Medical Centers of New York, Staten Island Region, New York USA;* [7]*SystAim GmbH, Pfingstweidstr. 31a, CH 8005, Zürich, Switzerland*

Diagnostic Accuracy of Canine Scent Detection in Early- and Late-Stage Lung and Breast Cancers

Michael McCulloch, Tadeusz Jezierski, Michael Broffman, Alan Hubbard, Kirk Turner, and Teresa Janecki

Mobile Labs

Process & Environmental monitoring
Wellhead monitoring
Emergency response
Chemical Weapons Convention
Chemical Warfare Agent Detection
Infectious Disease Detection



Organic Compound Analysis

Volatile Organic Compounds

VOCs

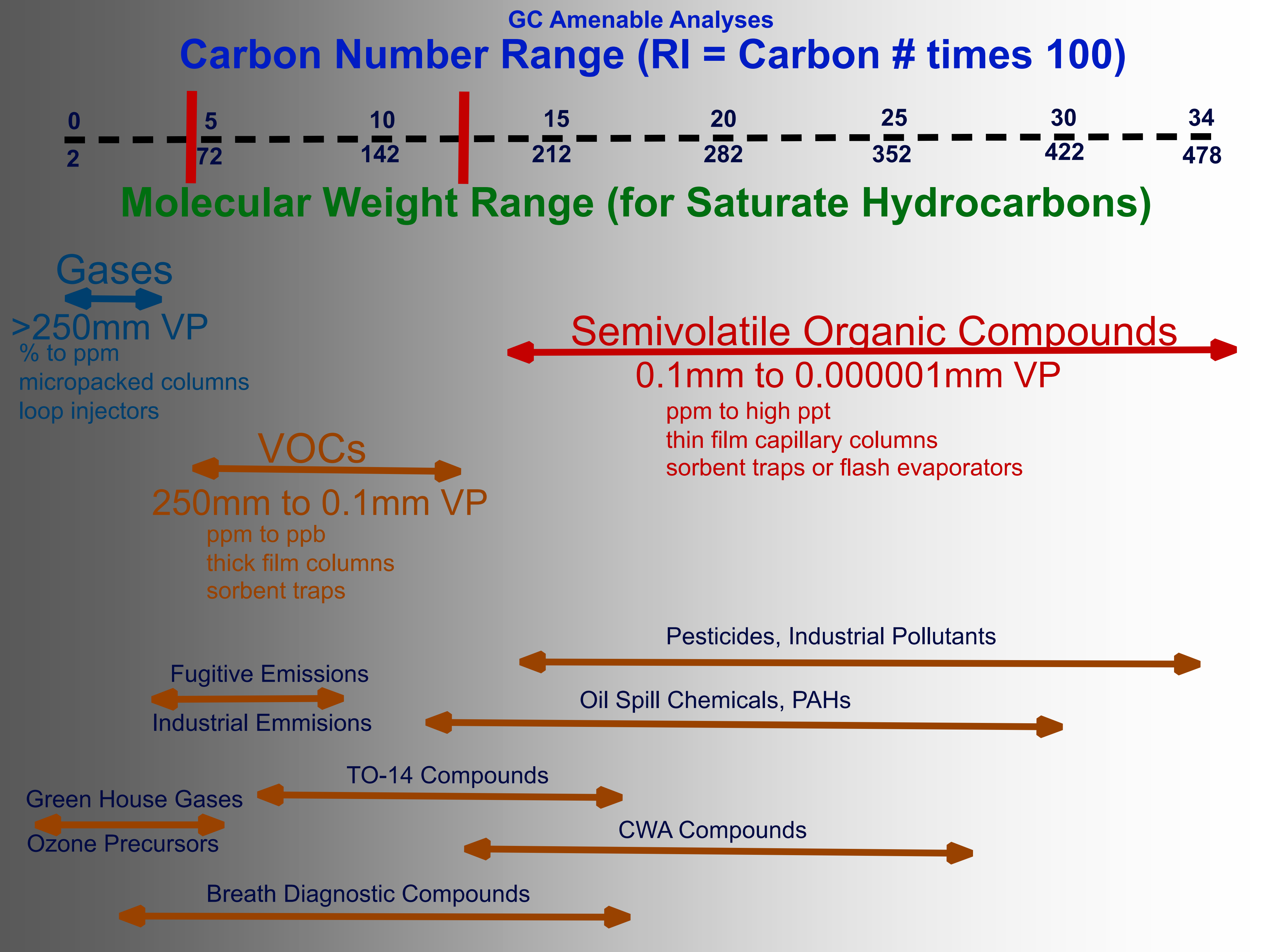
>3000 mm to ~0.1mm Hg VP

VC to DCB

Semi-volatile Organic Compounds

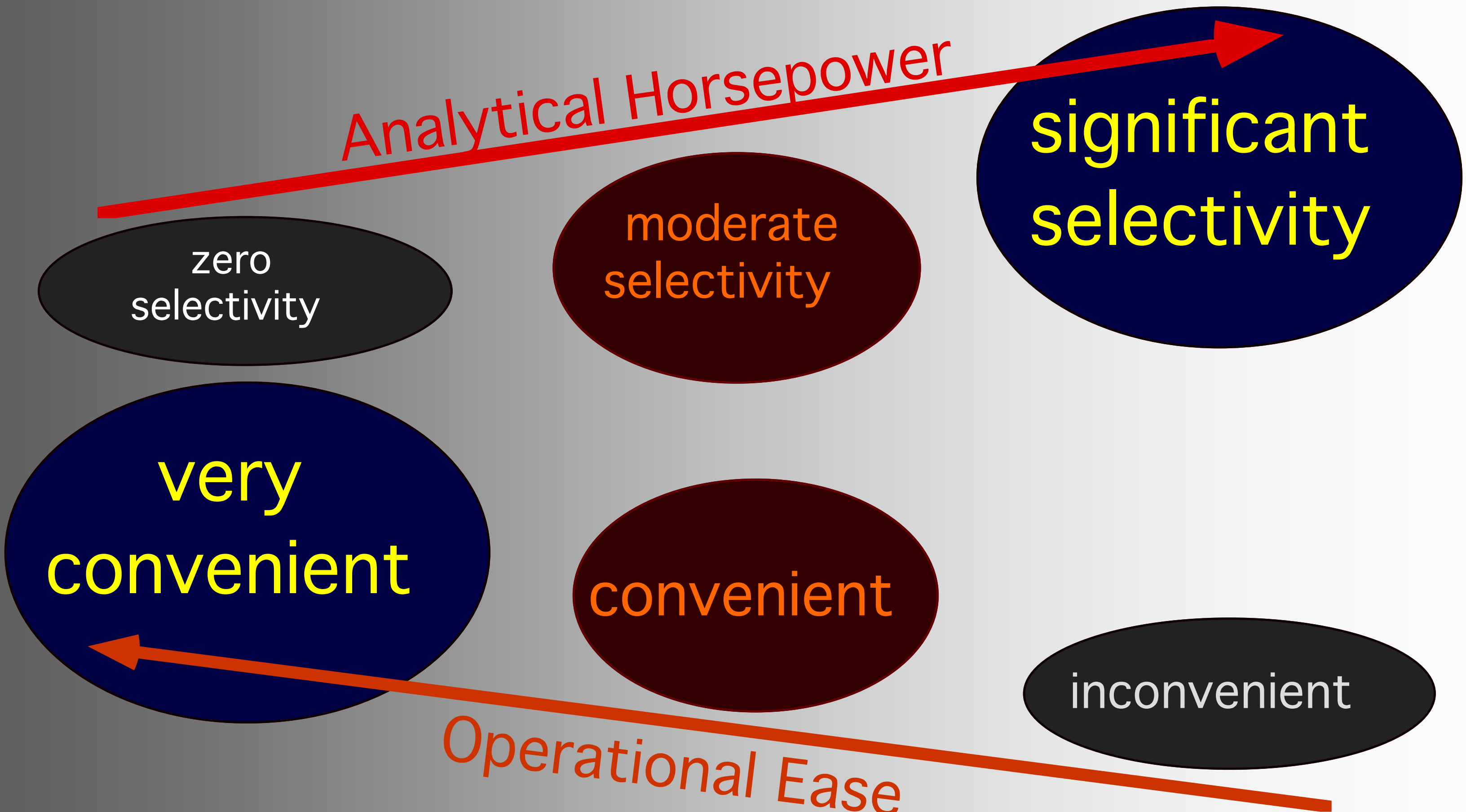
SVOCs

~0.1mm to 0.000001mm Hg VP


GC Amenable Analyses
Carbon Number Range (RI = Carbon # times 100)
0
5
10
15
20
25
30
34
2
72
142
212
282
352
422
478
Molecular Weight Range (for Saturate Hydrocarbons)
Gases
>250mm VP
% to ppm
micropacked columns
loop injectors
Semivolatile Organic Compounds
0.1mm to 0.000001mm VP
ppm to high ppt
thin film capillary columns
sorbent traps or flash evaporators
VOCs
250mm to 0.1mm VP
ppm to ppb
thick film columns
sorbent traps
Pesticides, Industrial Pollutants
Fugitive Emissions
Industrial Emmisions
Oil Spill Chemicals, PAHs
TO-14 Compounds
Green House Gases
Ozone Precursors
CWA Compounds
Breath Diagnostic Compounds

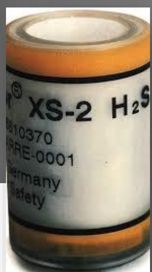
Compound Specific Analysis (tunably selective) = *Analytical Horsepower*

Portability (transportable to portable) = *Operational Ease*



Issues: false positives vs false negatives

Analytical Horsepower

Sensors





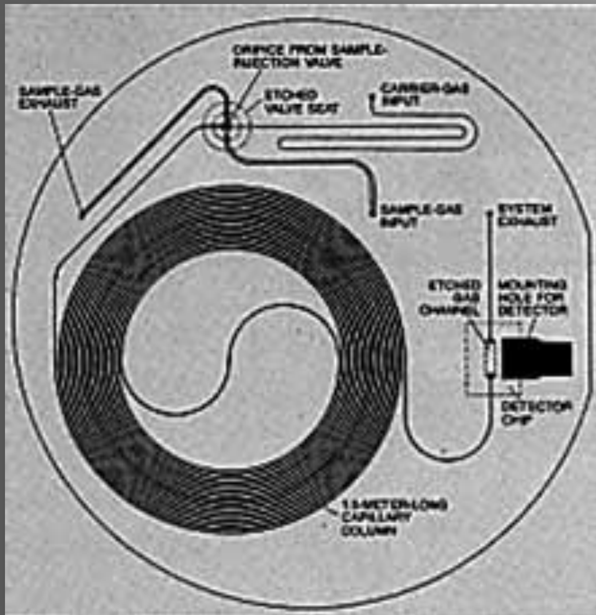
GC, IMS



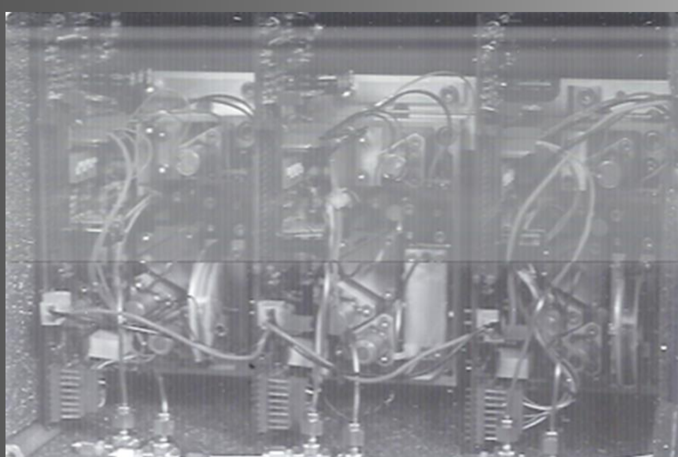

GCMS

Ease of Use, Cost

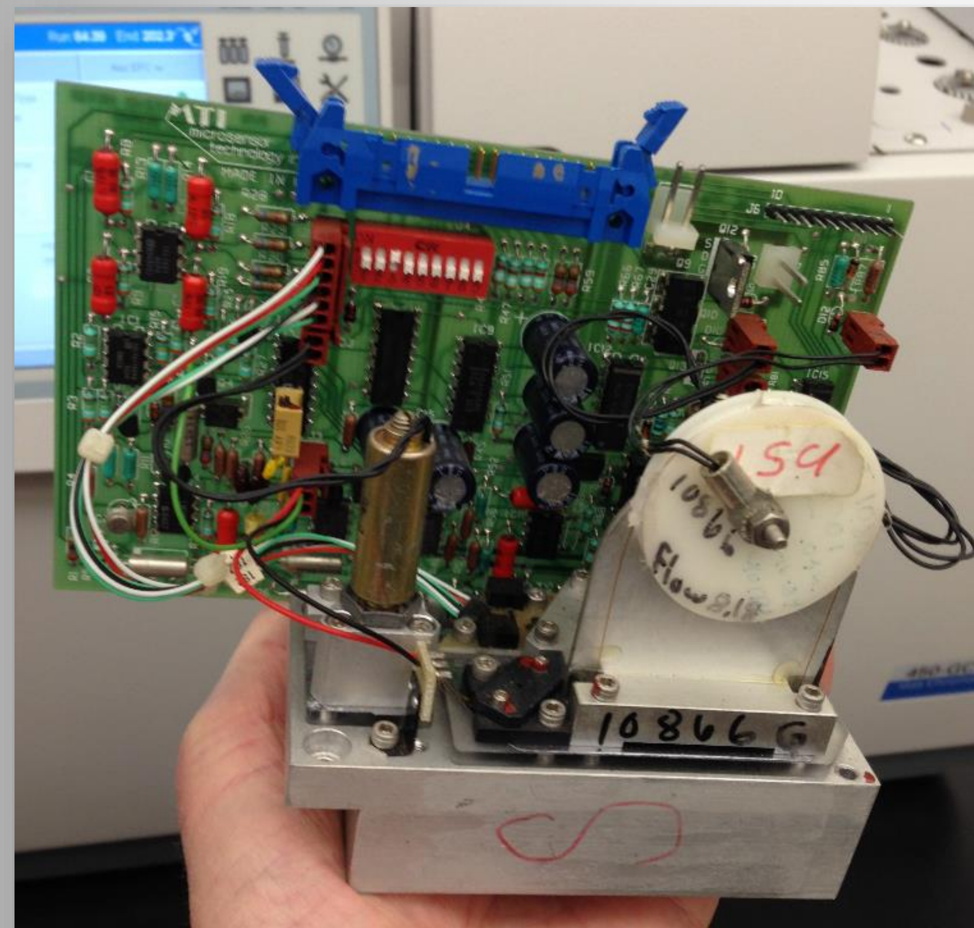
Stanford "GC on a chip"

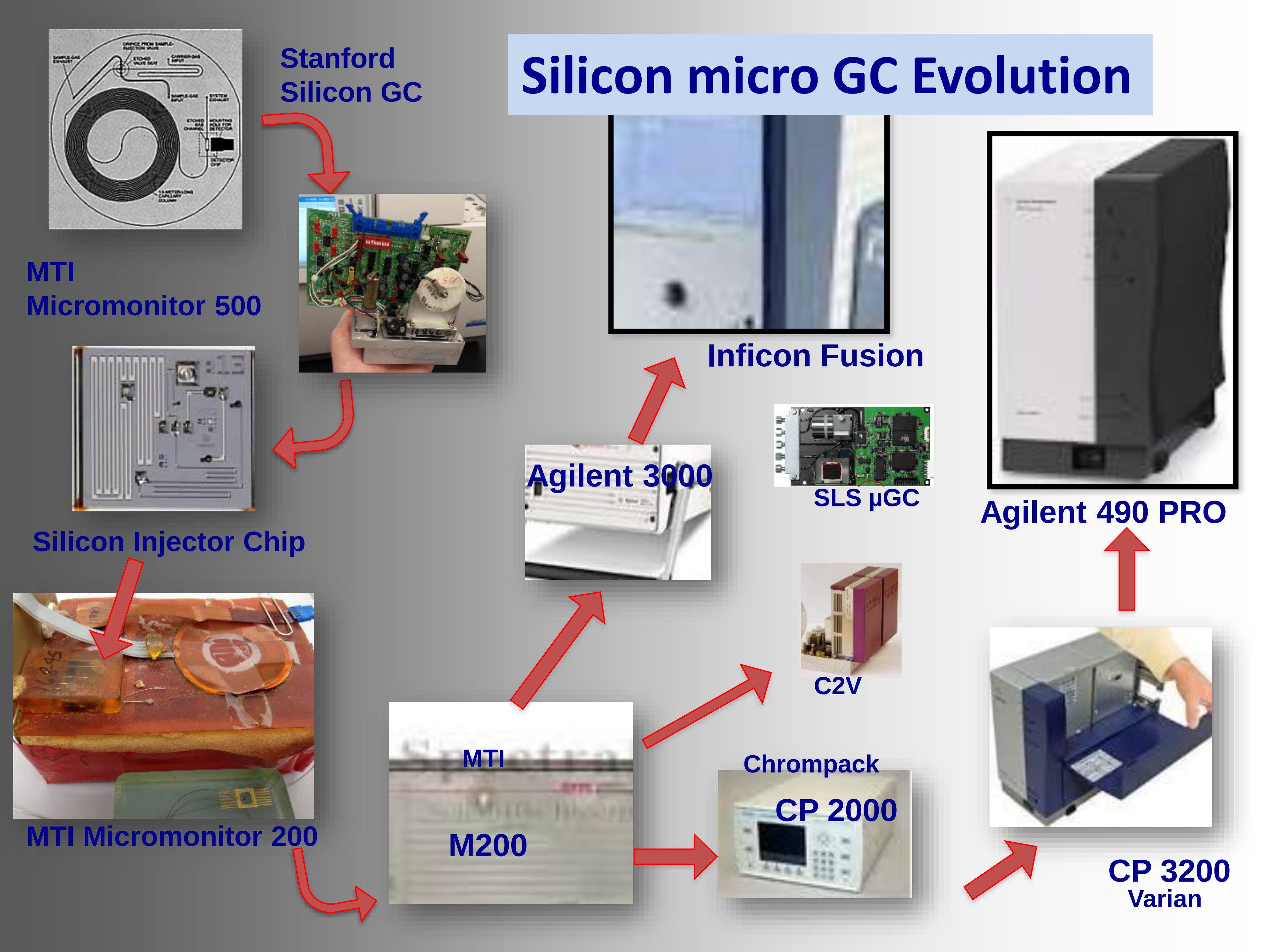


Micromonitor 500

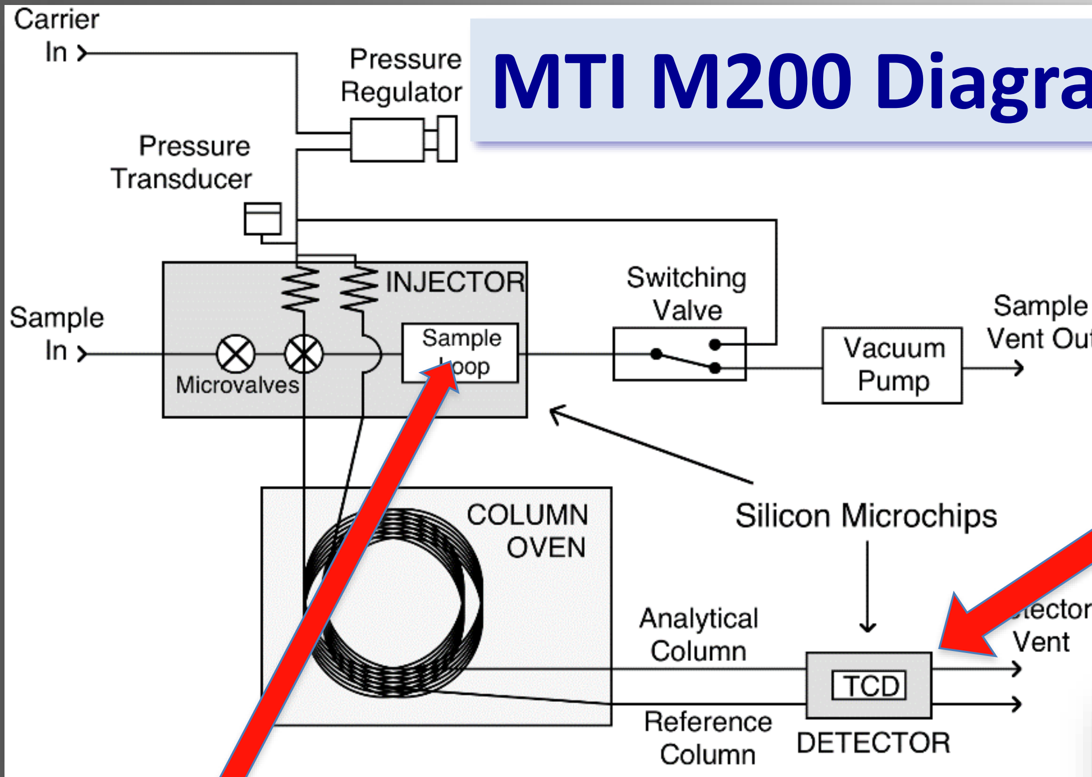


Microtech NGA




Silicon micro GC Evolution
Stanford Silicon GC
MTI Micromonitor 500
Silicon Injector Chip
MTI Micromonitor 200
MTI
M200
Agilent 3000
Inficon Fusion
SLS μGC
C2V
Chrompack
CP 2000
Agilent 490 PRO
CP 3200
Varian

MTI M200 Diagram



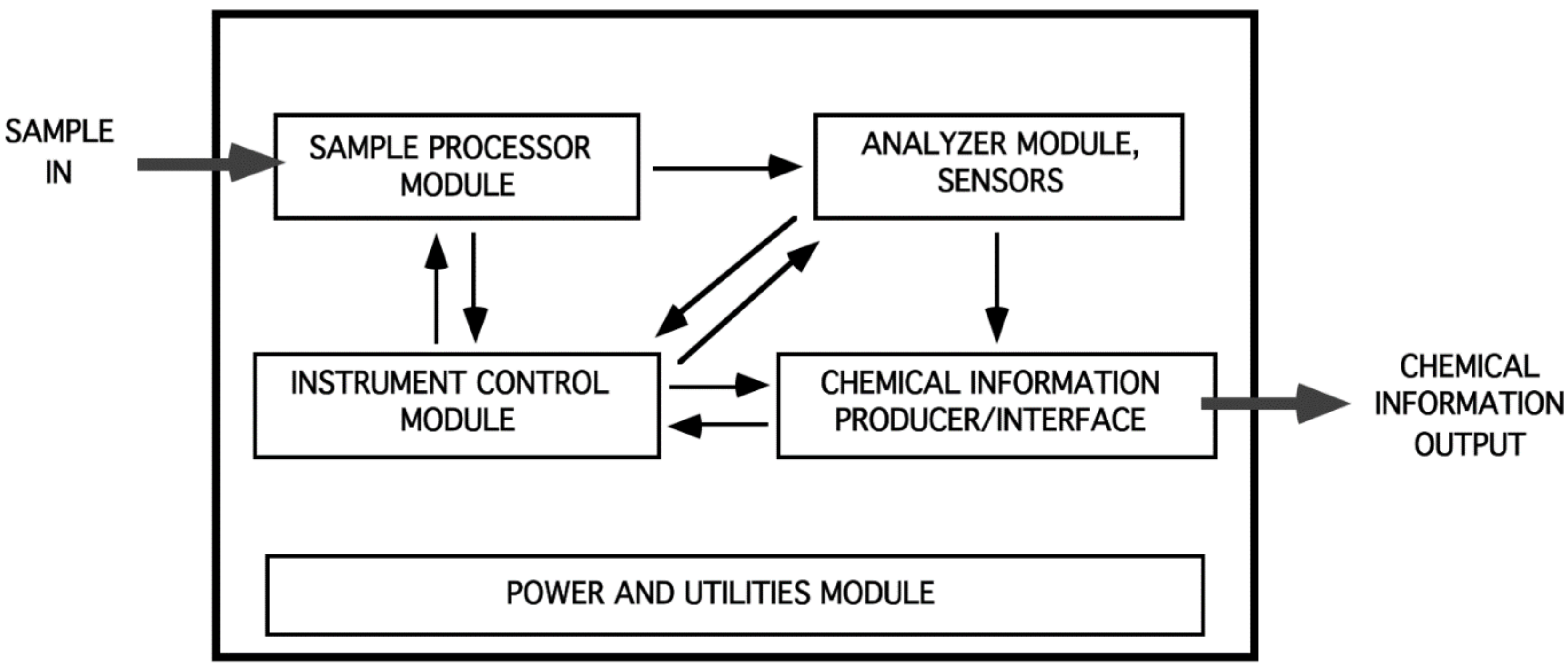
Silicon TCD

M200 GC module insulated

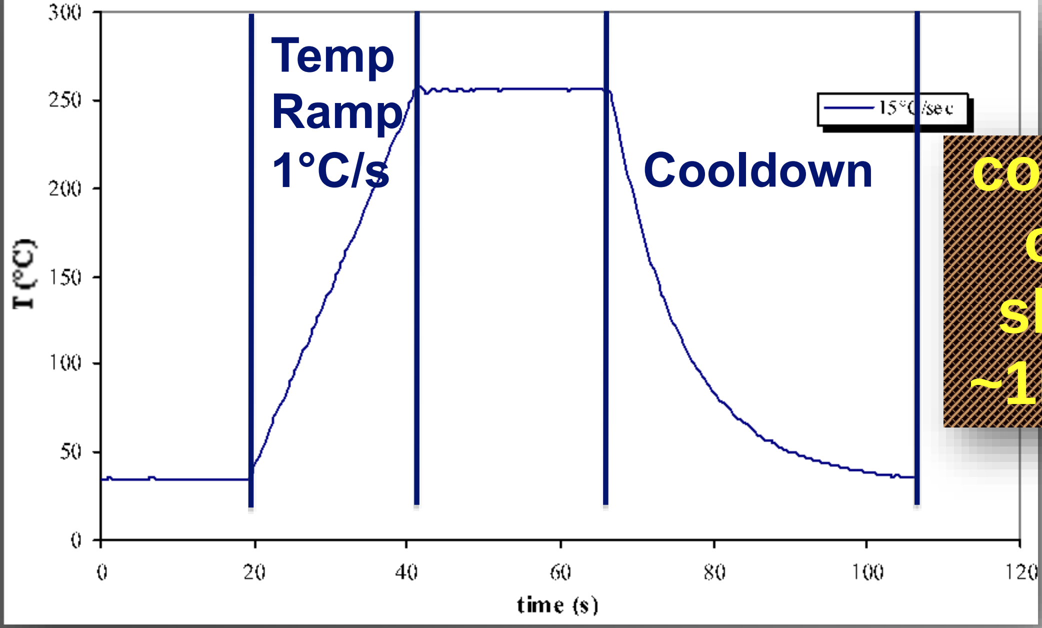
Acrylic encapsulated
Silicon injector chip

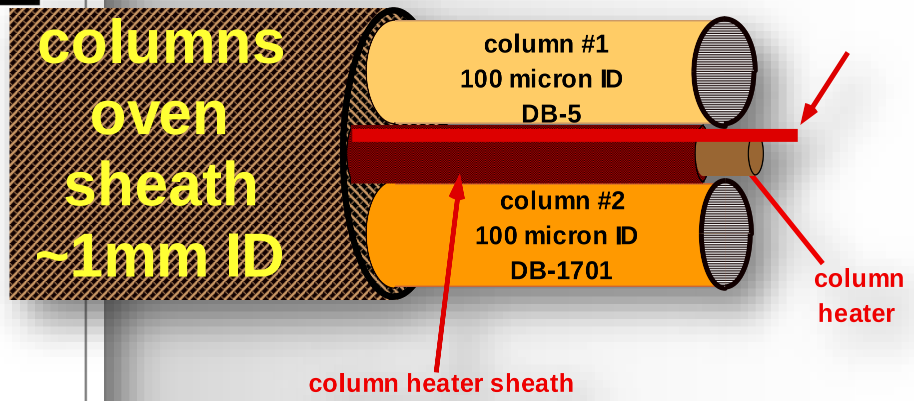
only gases
Ppm detection limits

IDEALIZED FIELDABLE ANALYTICAL INSTRUMENT
FUNCTIONAL DIAGRAM

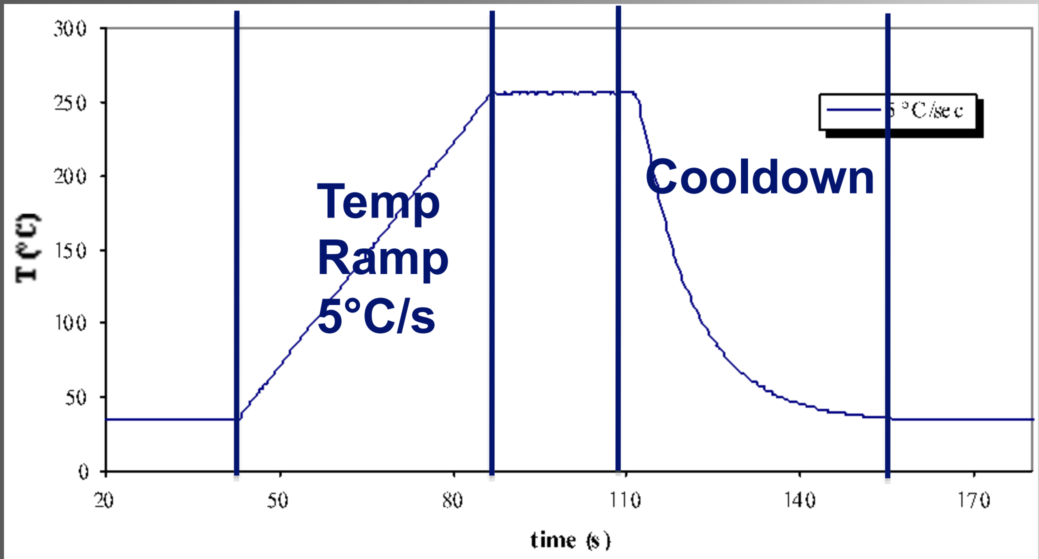


In the early 1900s, the DNA had a need for a portable analyzer for on-site detection of CWA precursors as required by the CWC.





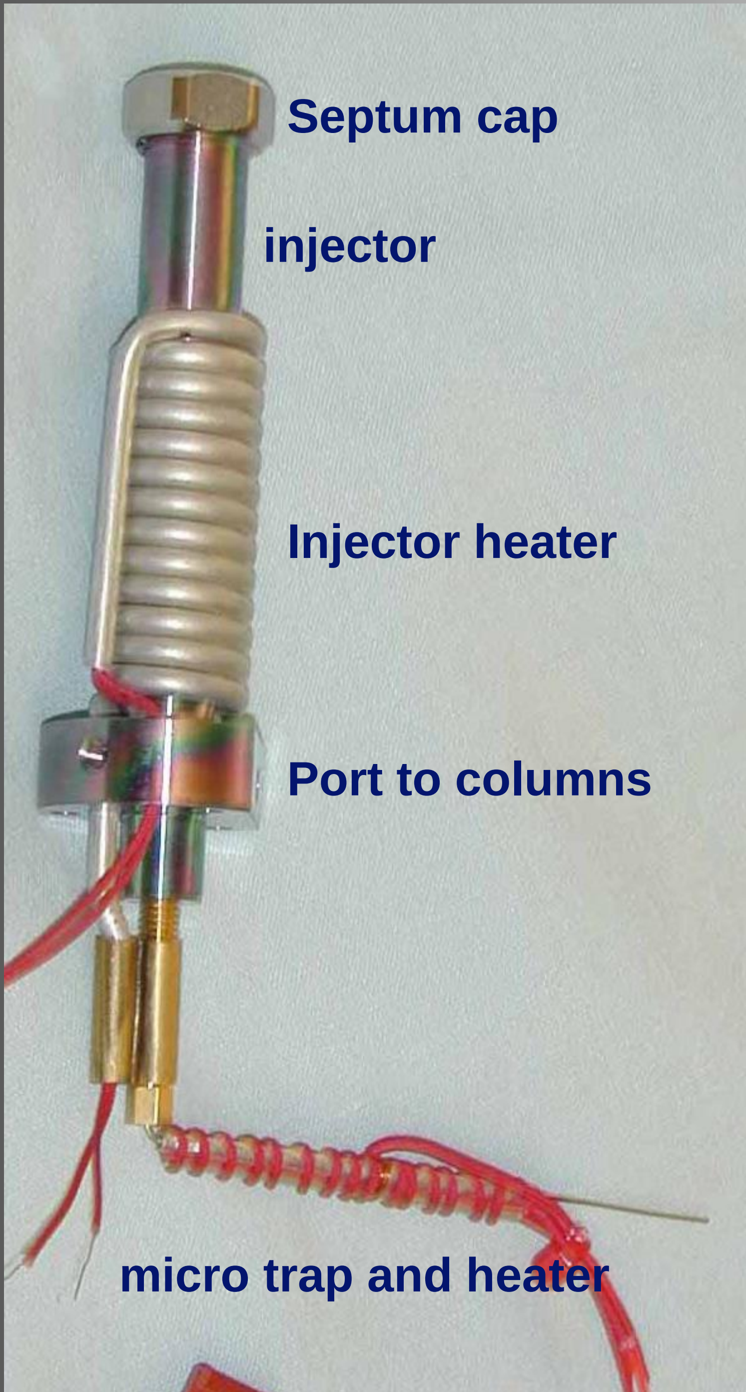
The microFAST GC's Column Temperature vs. Heating Rates



A GC needs HEAT! micoFAST GC delivered it.

What is the microFAST GC?

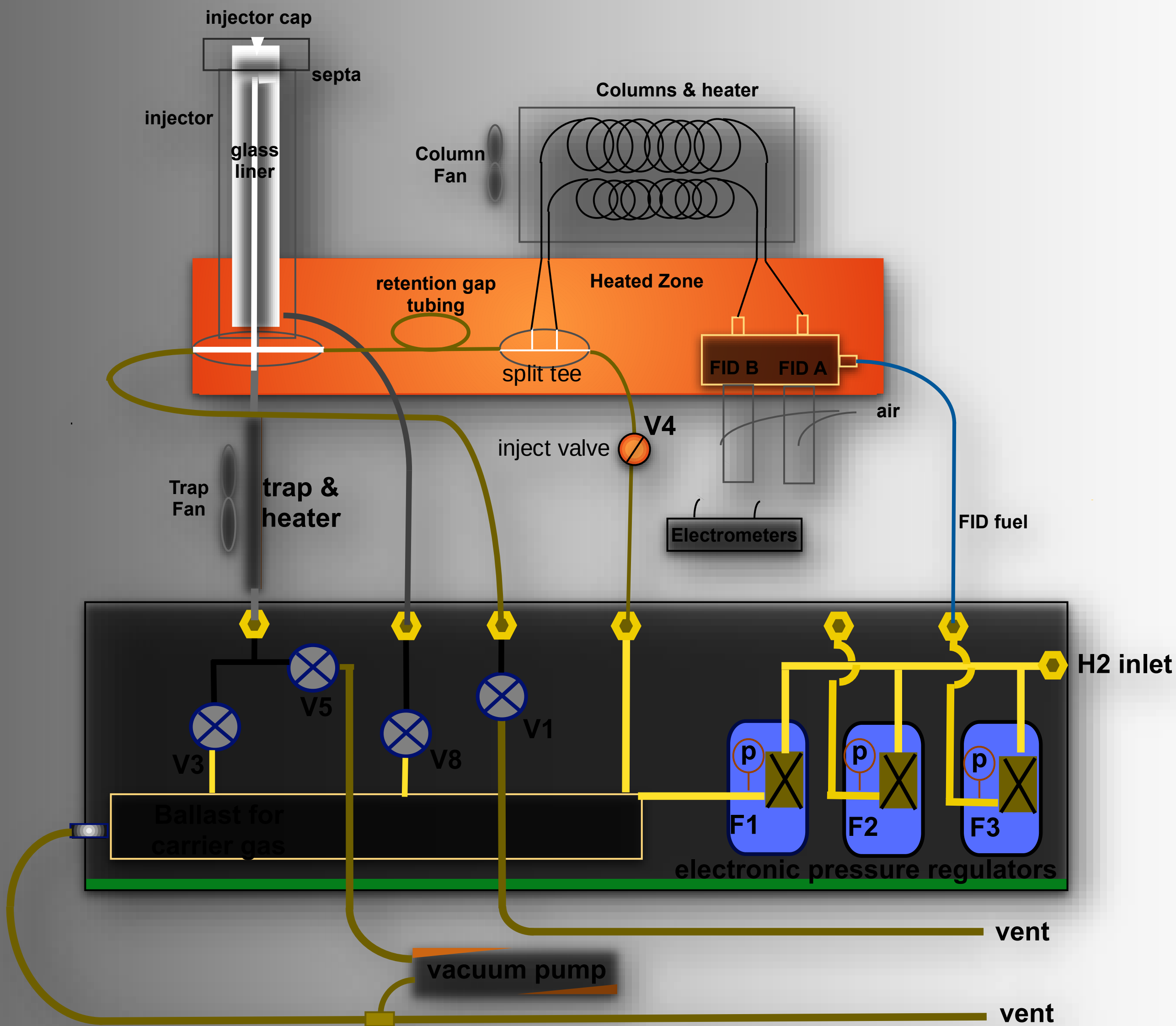
- A highly sensitive and selective micro gas chromatograph.
- A GC capable of very fast, low level compound measurements in the laboratory or field.
- Key features include *small size*, *ease of use*, *speed of analysis*, and *transportability*.
- Productivity and cost advantages over traditional GC units.

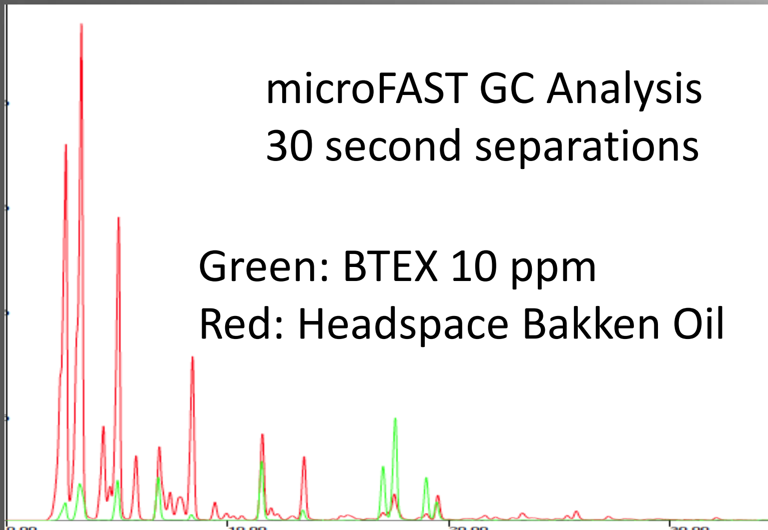


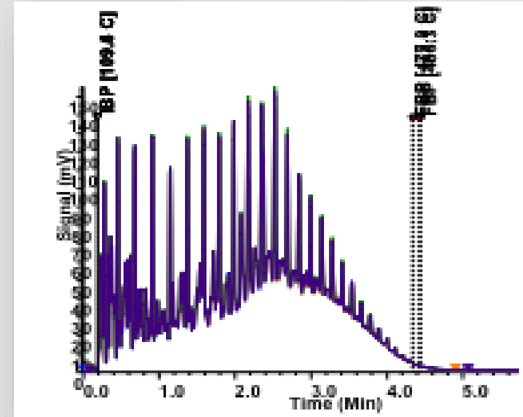
Concentration Trap Injector Facilitates Multi Sampling Capacity:

- Normal/large volume injections
- Gases, dilute gases (ppb level)
- Static and dynamic headspace
- SPME
- Membrane & external concentrators
- Purge and trap extracts
- Liquid organic solvent extracts
- Neat organic liquid mixtures
- Aqueous liquids
- Thermal desorption tubes
- Thermal and SCF extracts

microFAST GC Functional Diagram



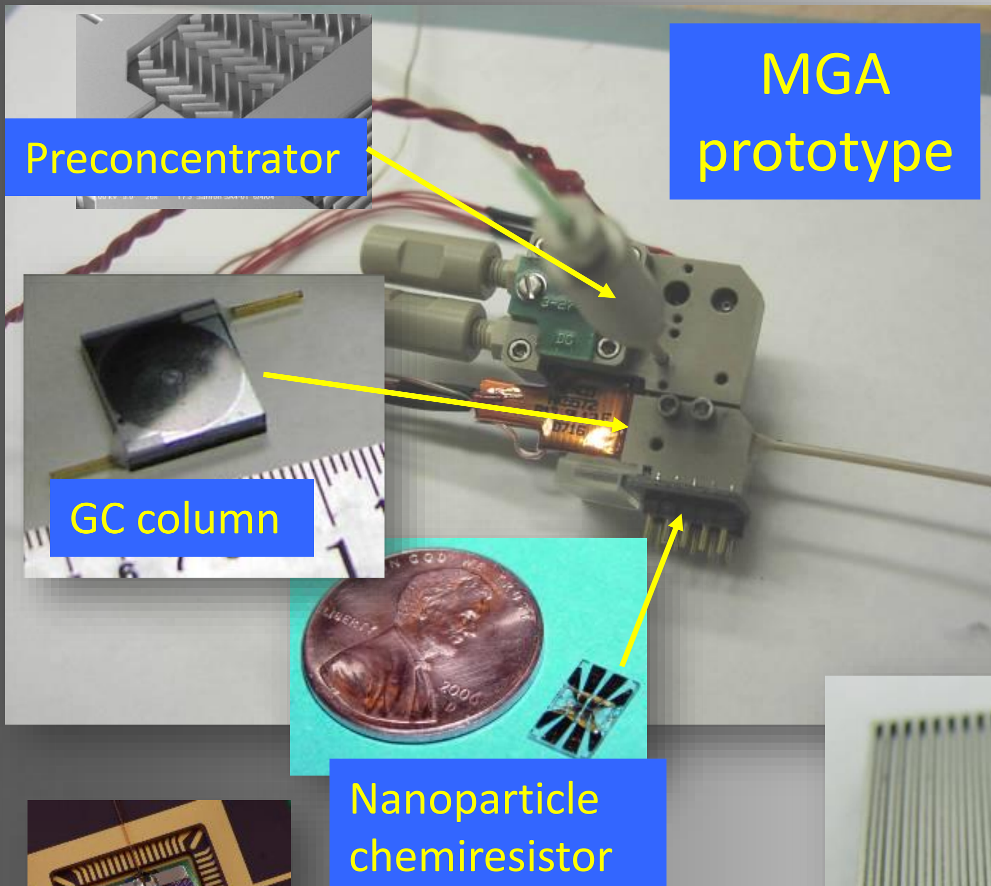


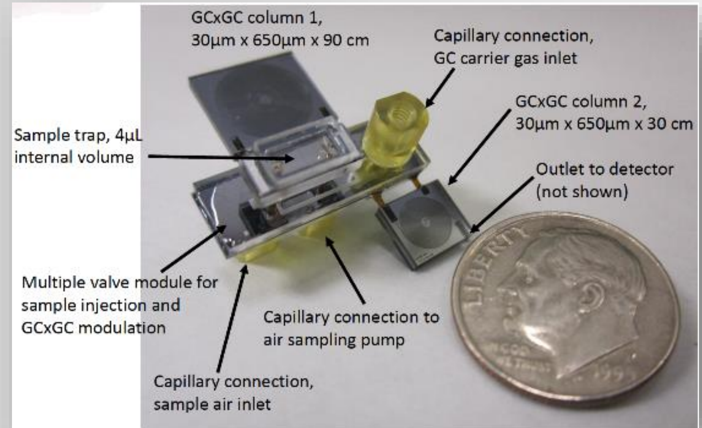


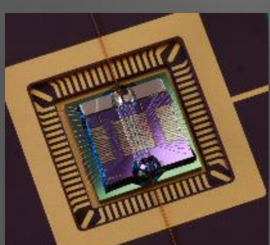
Falcon Calidus 101HT µGC

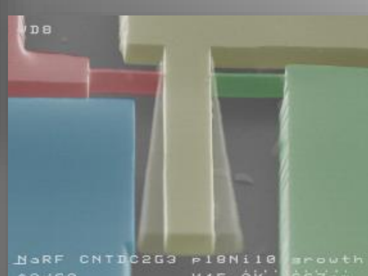
microFAST GC

Micro Fabricated GC Systems

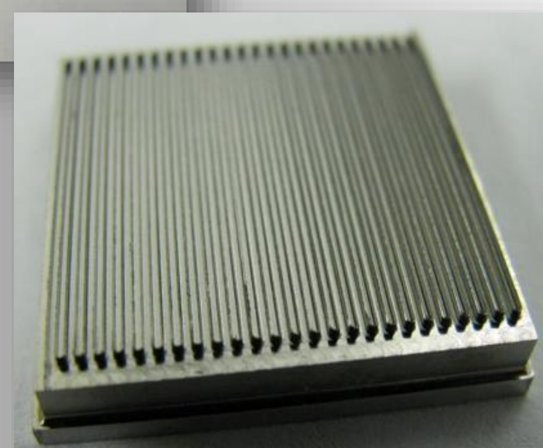






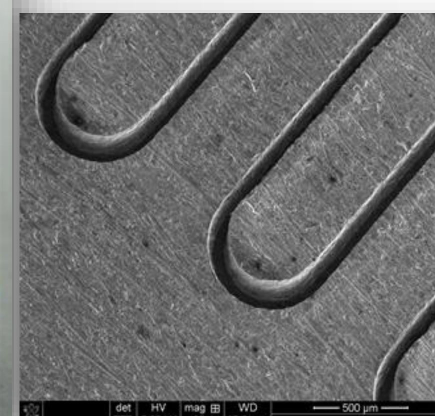


Vibrating Cantilever Detector



Mold Insert

Aluminum Column



Fast GC Analysis required extremely fast sample band injections

also fast temperature programming, fast detector response

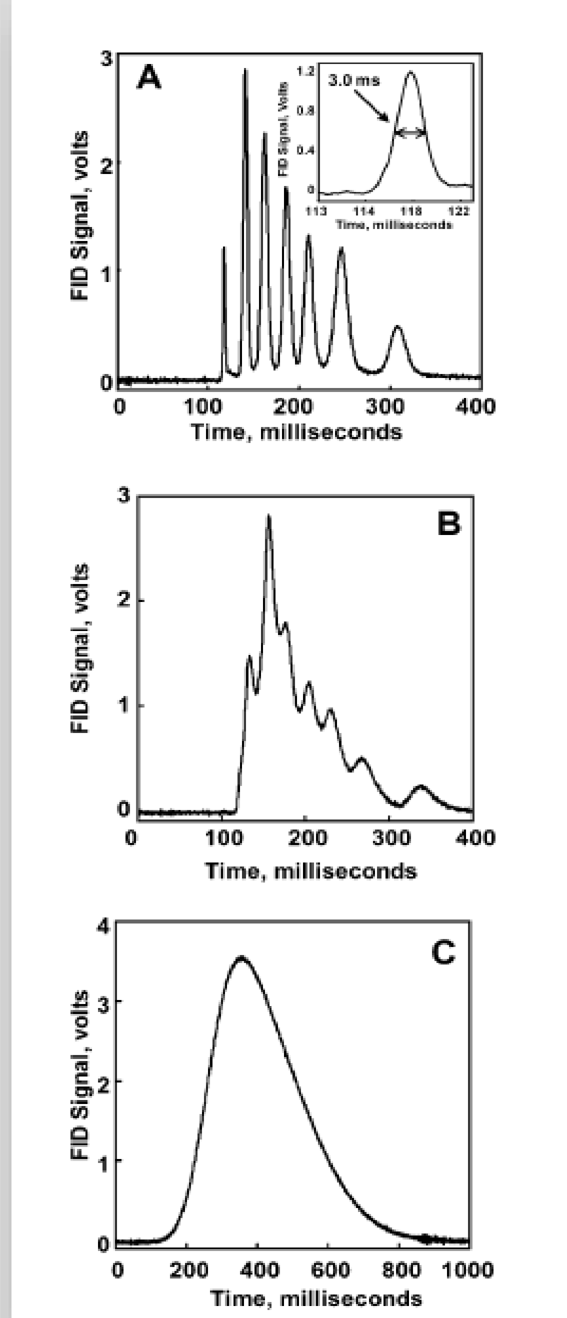
2.5 ms

20 ms

>1 sec

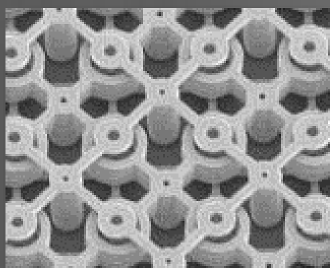
1 meter DB-5 column
100µ ID 0.4µ film
150° C isothermal
85 psi head pressure

Analytical Chemistry, Vol. 76, No. 13, July 1, 2004



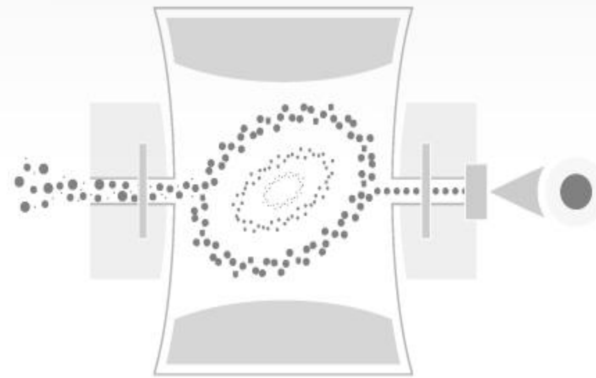
908 Devices

27 Drydock Ave., 8th Floor
Boston, MA 02210

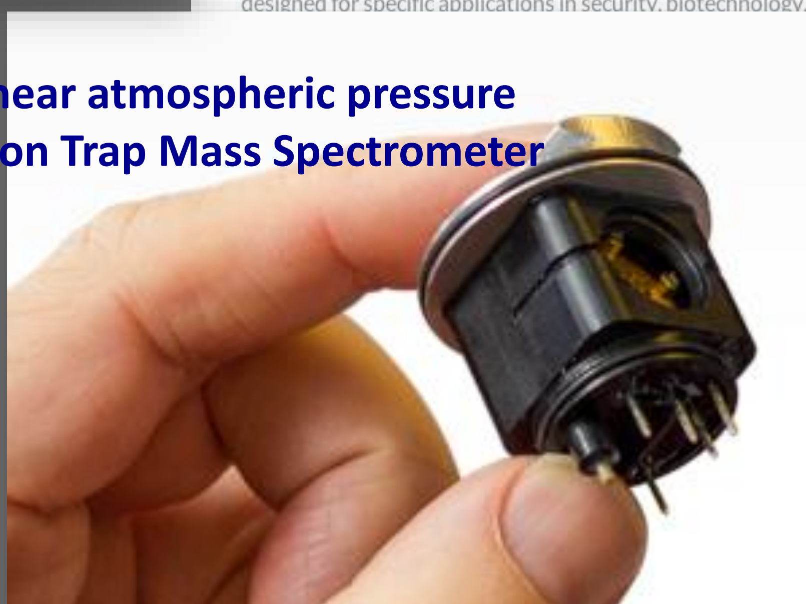


Purpose-built

Many applications just don't require all the complexity these laboratory platforms incorporate. We are building ridiculously small, and elegantly simple purpose-built products based on remarkable mass spectrometry technology. These systems are designed for specific applications in security, biotechnology,



near atmospheric pressure
Ion Trap Mass Spectrometer



Secret sauce

At the heart of our systems are molecular traps a thousand times smaller than those in conventional mass spectrometers. These diminutive traps can operate much closer to atmospheric pressures and enable us to use dramatically smaller pumps, ionizers, detectors and electronics than existing laboratory or luggable mass spectrometers. We call this

Questions?