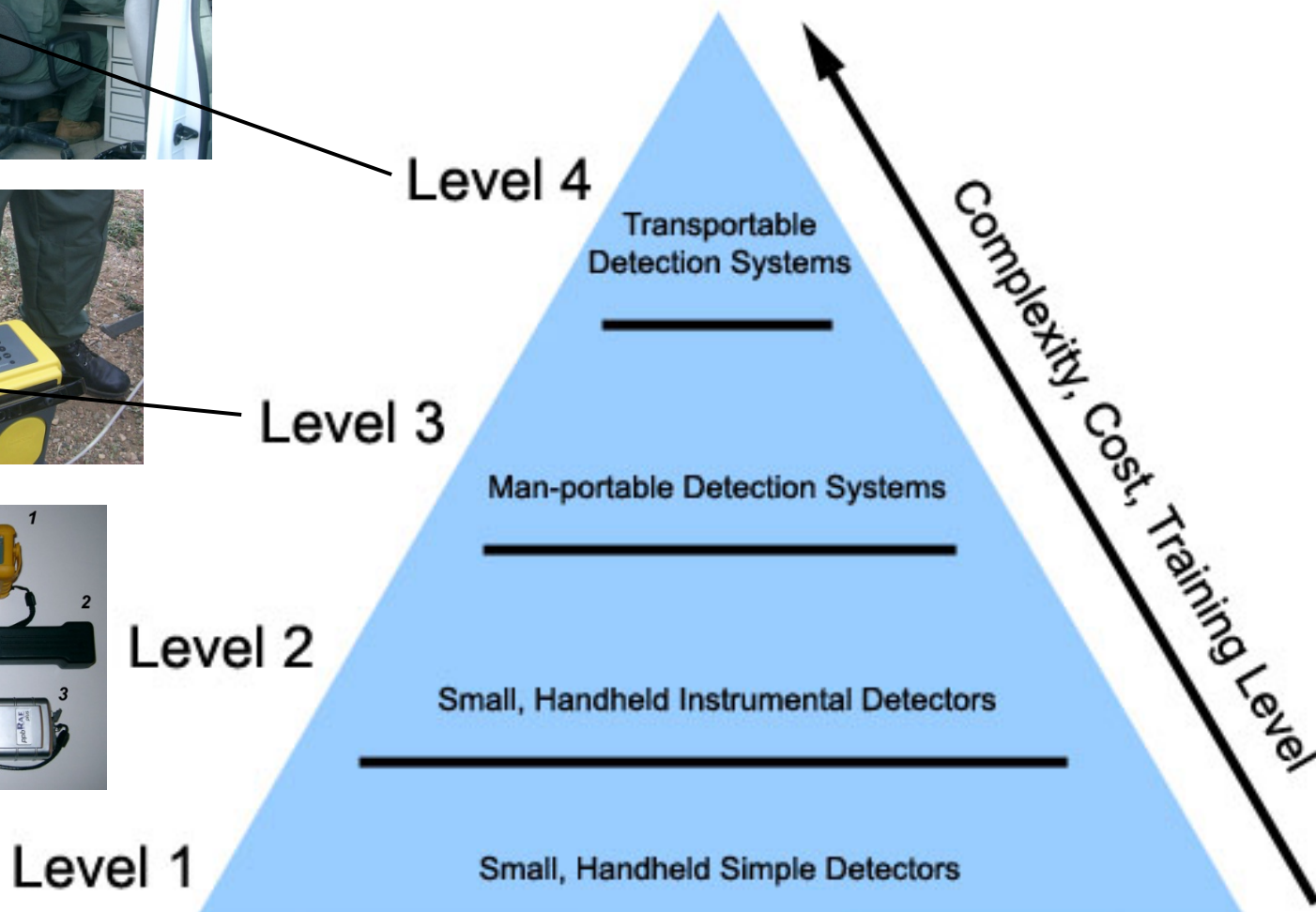


Field-Portable GC-MS for Human Exposure Assessment

Phil Smith, PhD, CIH

USDOL-OSHA
Health Response Team
Sandy, Utah

Real-Time Detection Hierarchy



GC Column Heating

1951-Present: A large air bath oven is typically used for laboratory instruments; provides good temperature control and uses a fan to minimize gradients

1984 –Lee, Yang, and Bartle discuss the possibility that heating only a modern fused silica GC column could be done rapidly using very little power –fast cooling as well

Beginning in 1989: Numerous researchers describe resistive heating methods to avoid heating the entire metal oven and one method in particular has become a commercial success

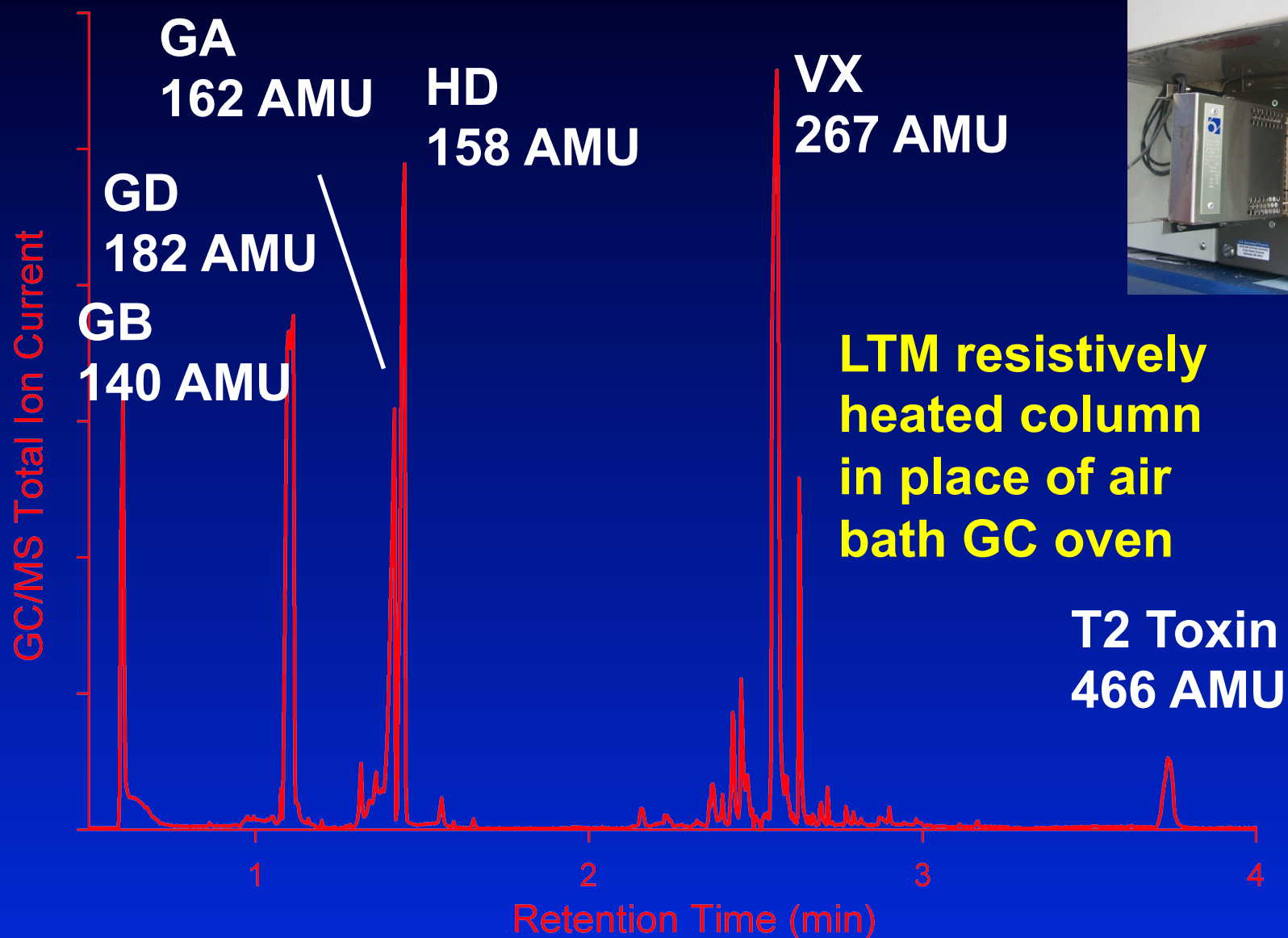
Towards Field Portable GC-MS with Faster Analysis Using Less Power



Resistively heated LTM GC column
(externally mounted)

Rapid Combined Sampling/Analysis

5 min SPME sample from contaminated water



Fieldable GC-MS Systems



Sample Preparation and Introduction are Substantial Issues for Field GC Analysis

Needed Attributes: Must be simple and solventless

Candidate Technologies:

(1) Integrated Direct Air Sampling

Volatility limitations

(2) Traditional Thermal Desorption of Sorbent

Bulky external equipment

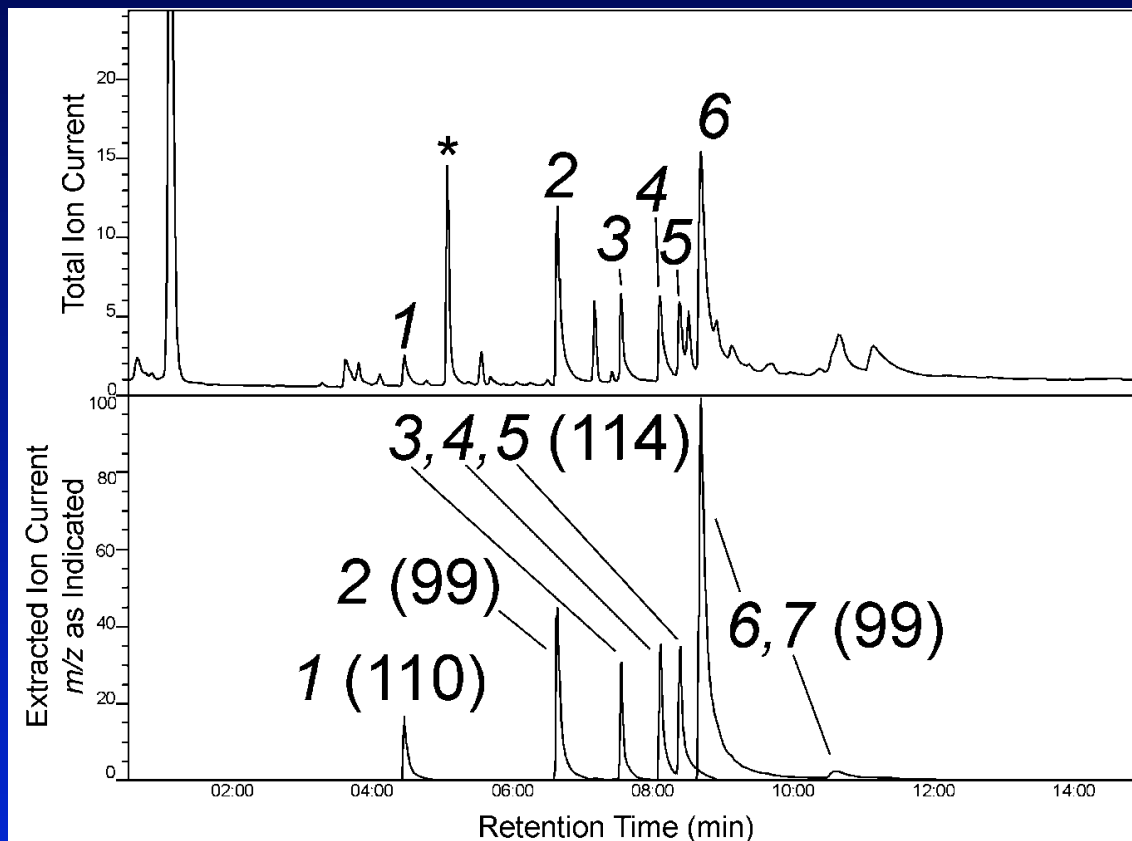
(3) Solid Phase Microextraction (SPME)

(4) Needle Trap Sampling

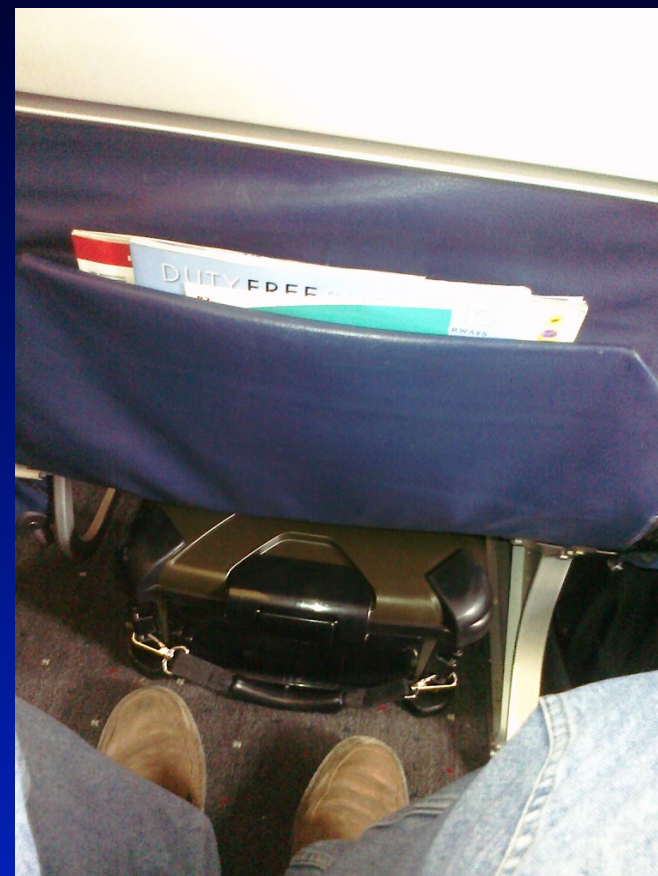
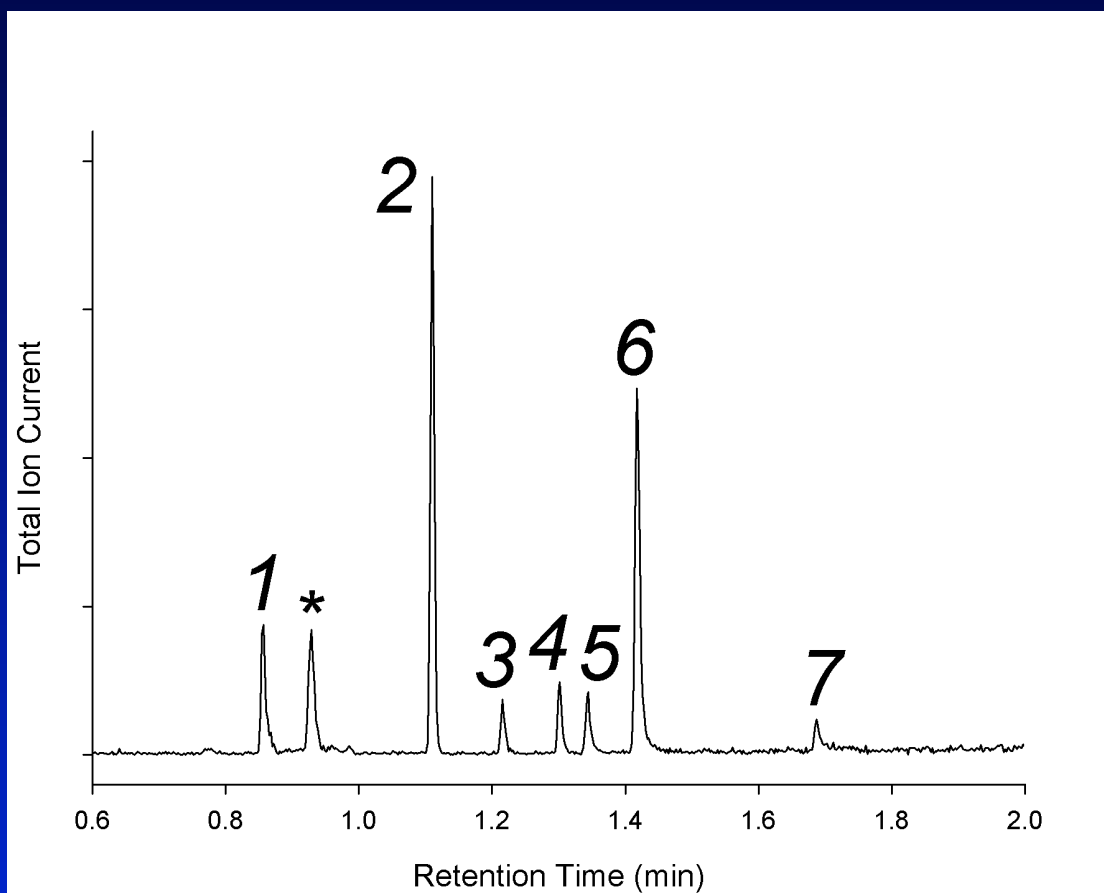
1st Generation Person-Portable GC-MS: Integrated Direct Air Sampling



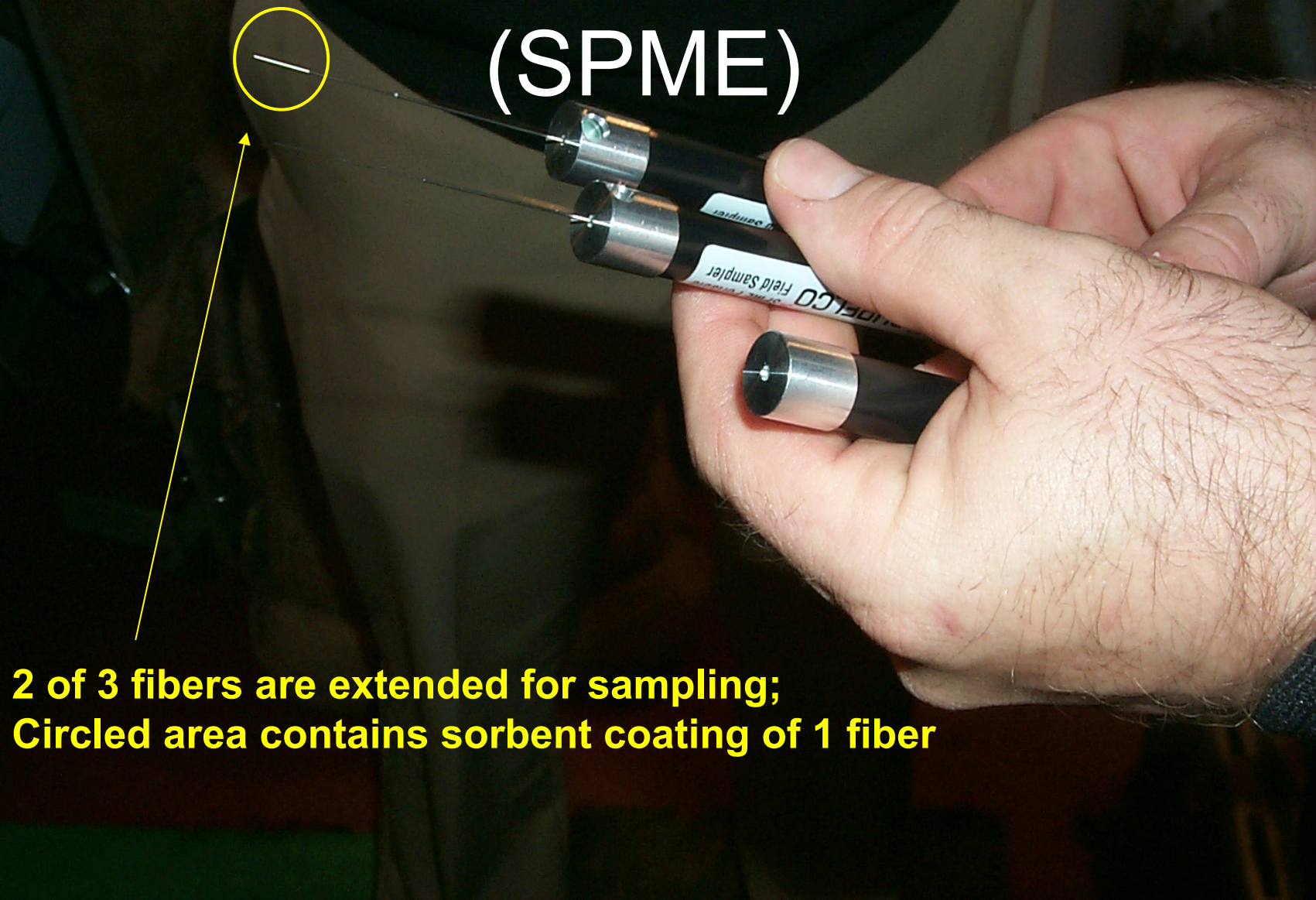
Chemical (NEG) high vacuum pump –requires membrane interface between GC and MS to Maintain vacuum



2nd Generation Person-Portable GC-MS



Solid Phase Microextraction (SPME)

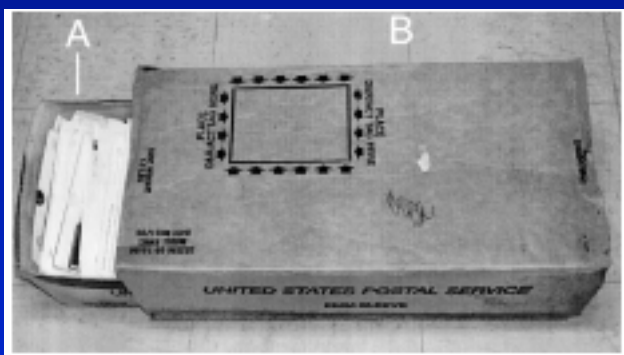


**2 of 3 fibers are extended for sampling;
Circled area contains sorbent coating of 1 fiber**

GC-MS/SPME Field Analysis: Irradiated Mail

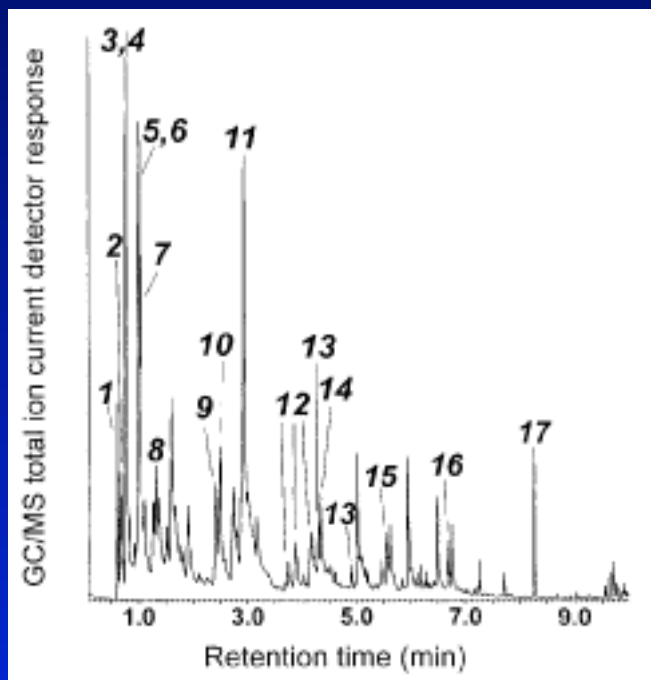
Problem: Initially unknown exposures to volatile organic chemicals among legislative workers handling mail irradiated as a protection against anthrax

- (1) Complex mixture with many trace components
- (2) Initially, composition completely unknown

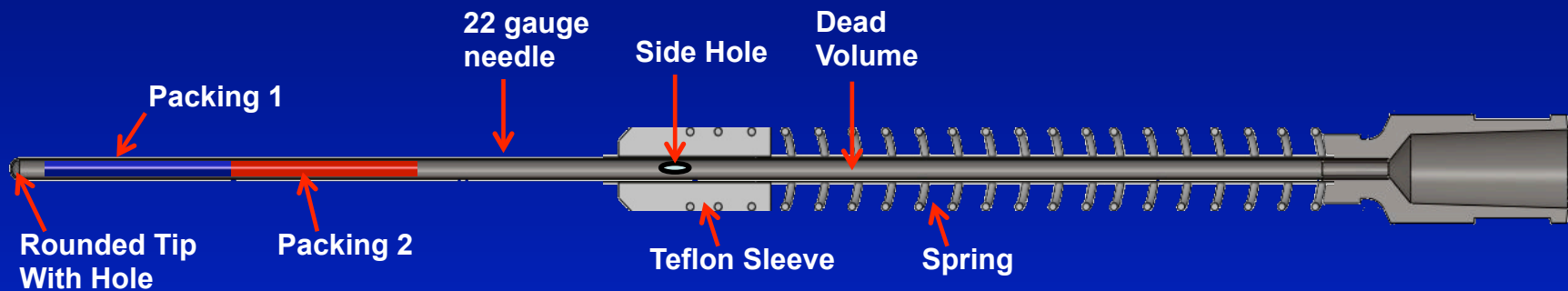


GC/MS with Mobile Laboratory

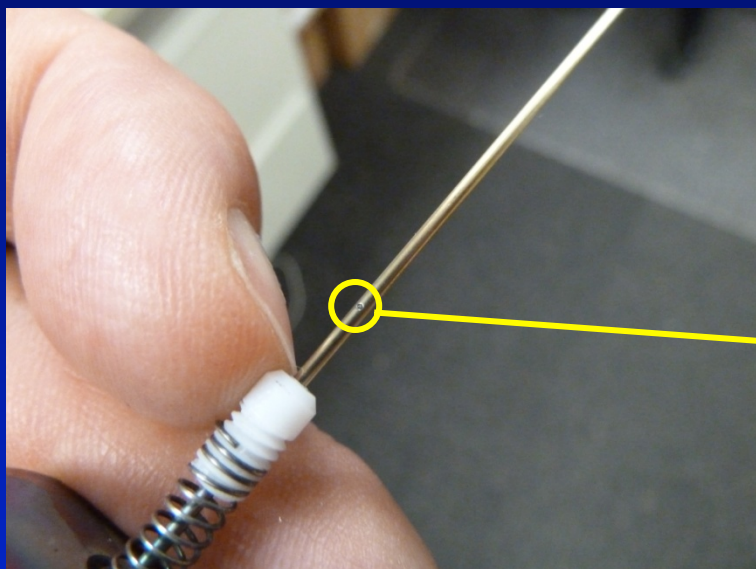
Initial screening samples showed rich mix of volatile organic compounds; poor GC resolution meant that different column was needed...



Needle Trap Sampler



Several milligrams of different sorbents with increasing strength packed in small needle (similar to large tubes except for scale)



Side Hole

- vacuum applied here during sampling
- serves as carrier gas inlet during desorption

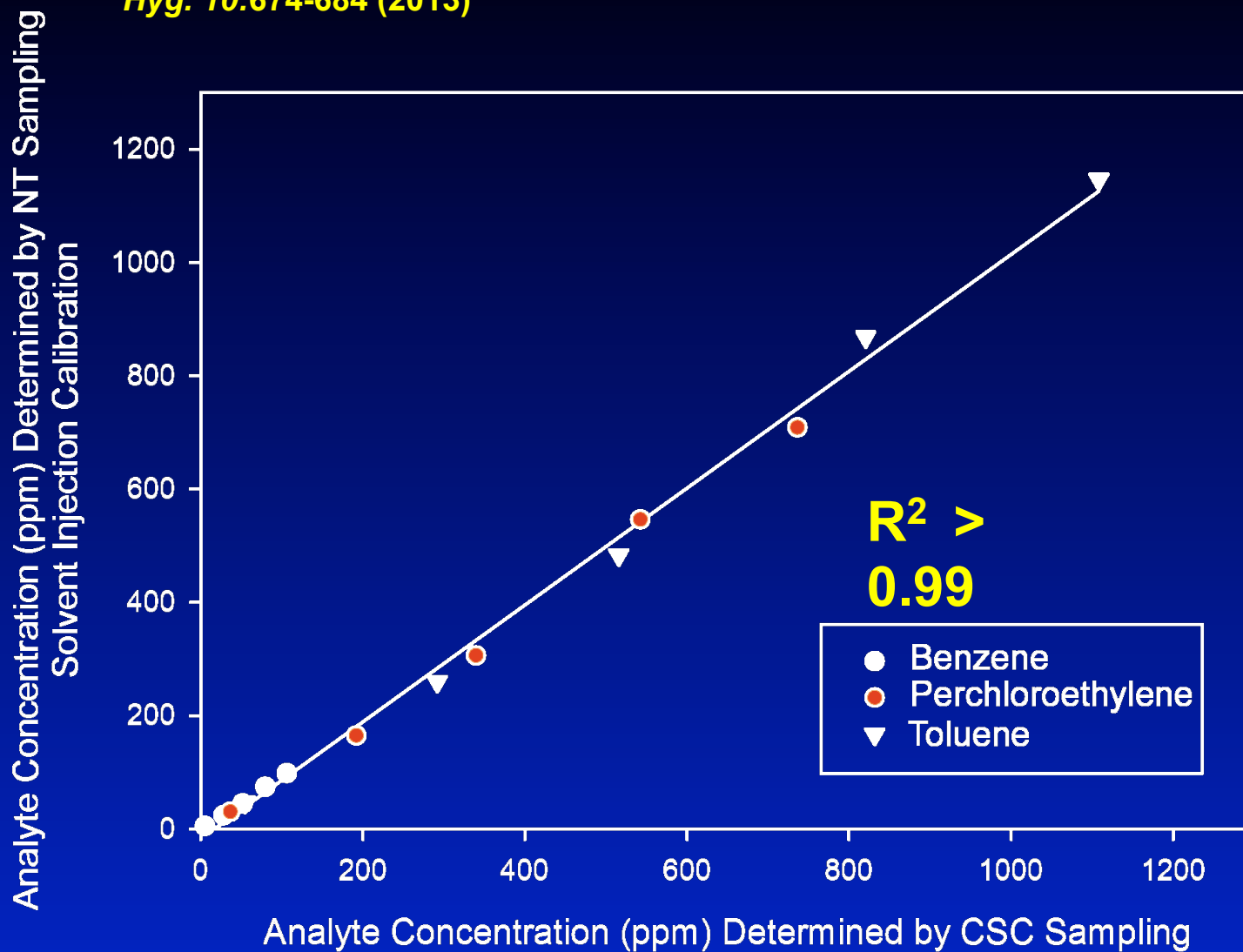
Needle Trap Breakthrough

	10 mL	20 mL	30 mL	50 mL
Methylene Chloride 125 ppm (15 min STEL)	No	Yes	Yes	Yes
Toluene 500 ppm (peak)	No	No	Yes	Yes
Benzene 5 ppm (15 min STEL)	No	No	No	Yes
Perchloroethylene 500 ppm (peak)	No	No	No	Yes

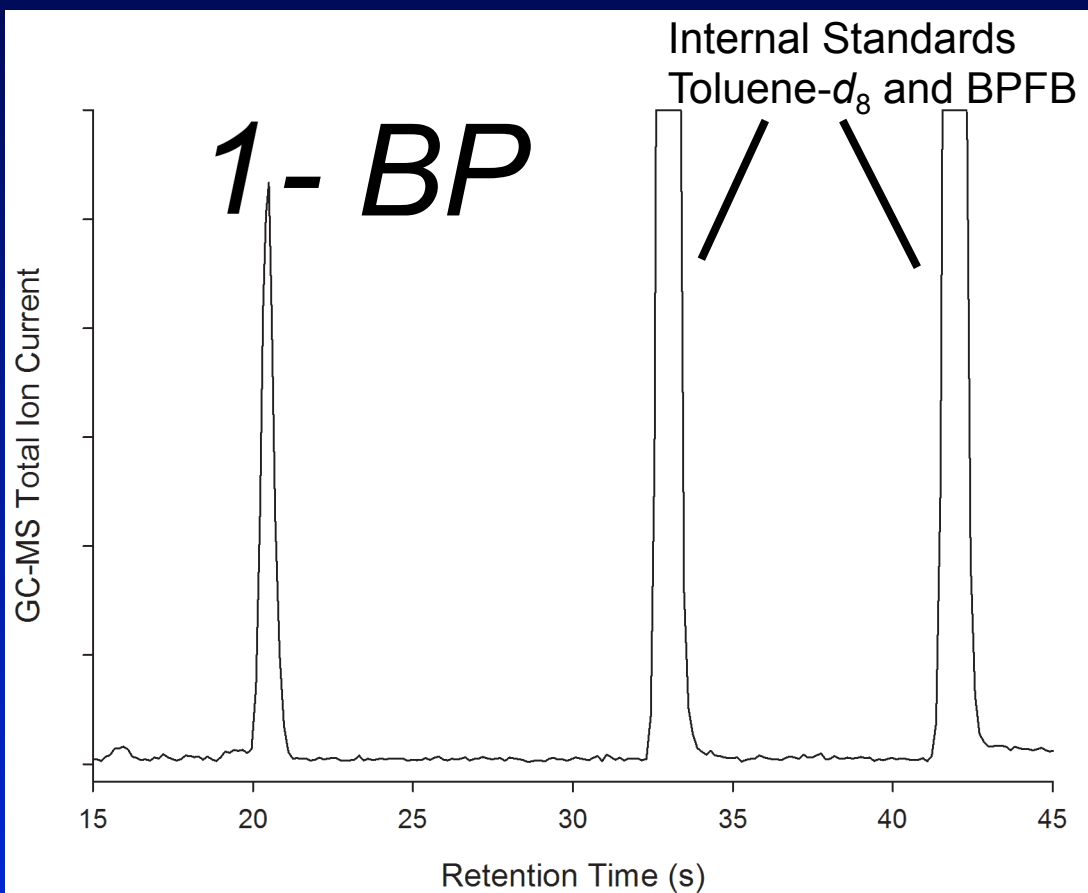
NT packed with 6 μ L methacrylic acid and ethylene glycol dimethacrylate solid sorbent

From Strating *et al.*: Short Duration Needle Trap Sampling to Determine Nearly Instantaneous Concentrations of Selected Organic Vapor Contaminants. *J. Occup Environ. Hyg.* 10:674-684 (2013)

From Strating *et al.*: Short Duration Needle Trap Sampling to Determine Nearly Instantaneous Concentrations of Selected Organic Vapor Contaminants. *J. Occup Environ. Hyg.* 10:674-684 (2013)

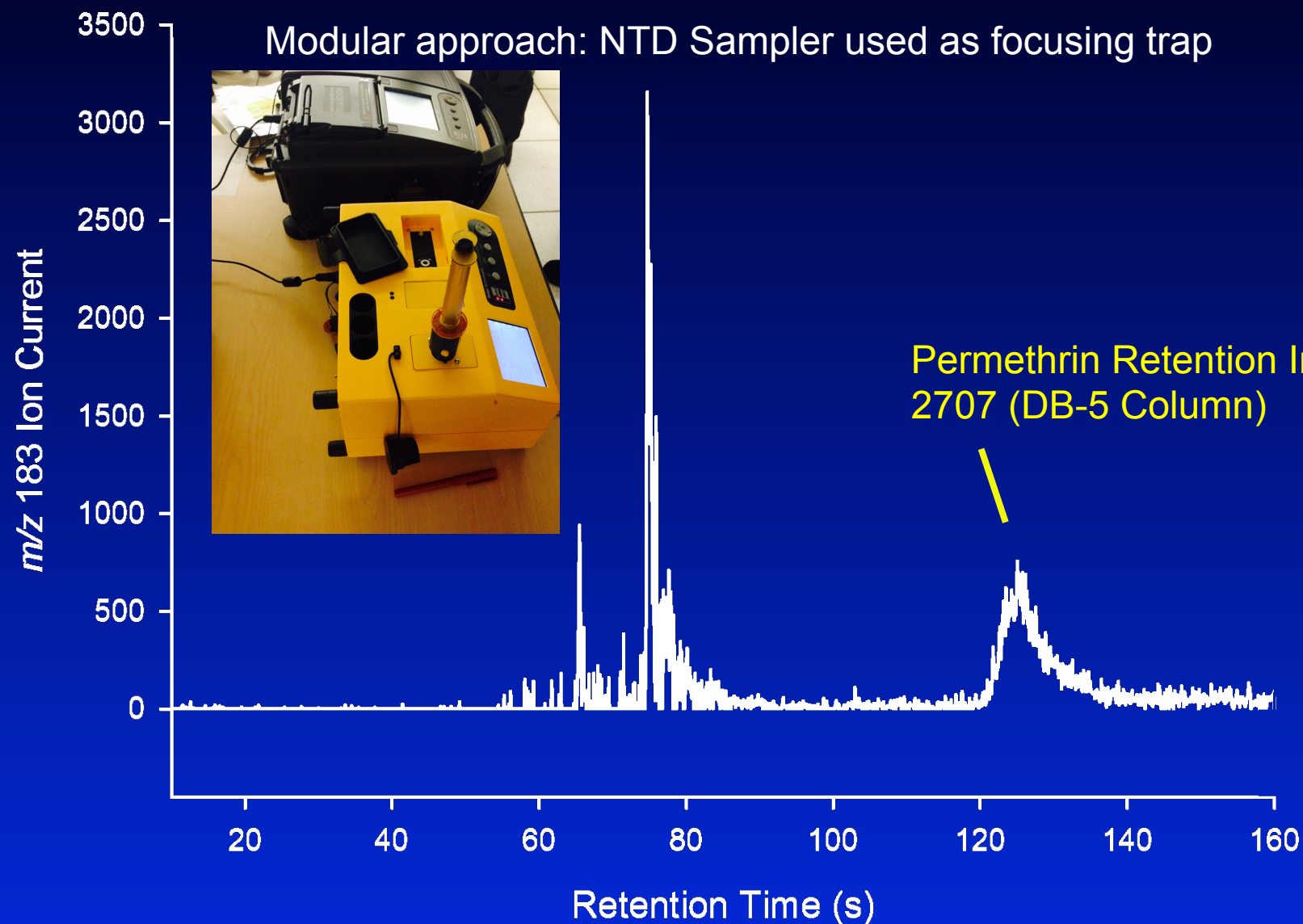


Interfering Air Contaminants Ruled Out



89 mm Thermal Desorption Tube Sampling of Airborne Permethrin

Modular approach: NTD Sampler used as focusing trap





BUSINESS

Why Did These Oil Workers Die?

Natural causes were blamed, but the focus has shifted to hydrocarbon chemicals



A worker checks water levels and temperatures at an Encana Oil & Gas hydraulic fracturing operation outside Rifle, Colo. PHOTO: BRENNAN LINSLEY/ASSOCIATED PRESS

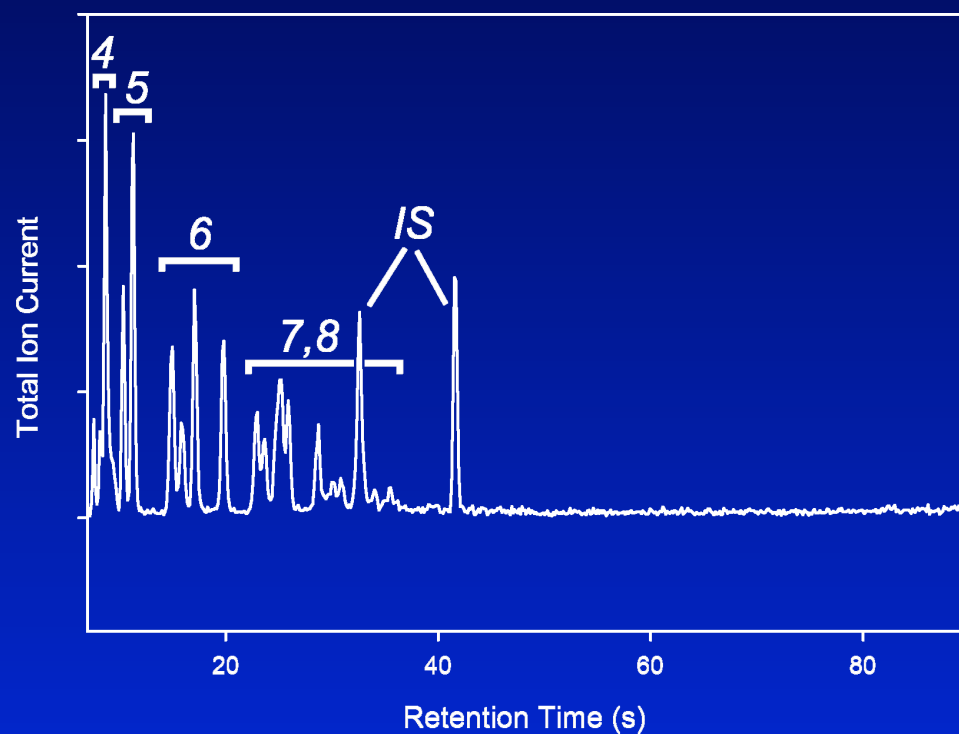
By ALEXANDRA BERZON

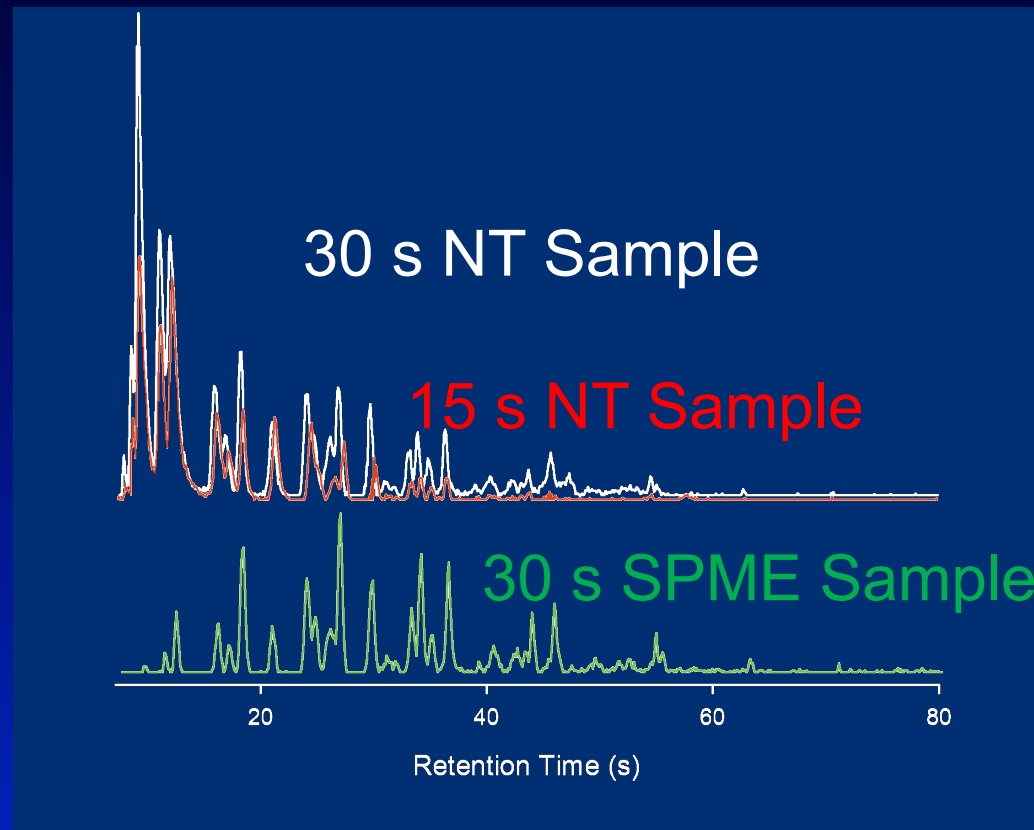
April 21, 2015 8:53 p.m. ET

54 COMMENTS

Field GC-MS Analysis of Needle Trap Samples

To avoid the loss of light hydrocarbon gases, whole-air breathing zone samples were immediately collected onto a tri-bed needle trap for analysis by field-portable GC-MS





Conclusions

Resistively heated open tubular GC columns have revolutionized field GC

Needle trap sampling employs a very small sorbent volume (breakthrough), but can provide similar quantitation as traditional sorbent tube sampling

SPME can be used quantitatively, but is better suited for qualitative analysis

Traditional 89 mm thermal desorption can be used with greater air sample volume compared to needle trap; additional equipment is needed to focus analytes from large tube for introduction to a GC system