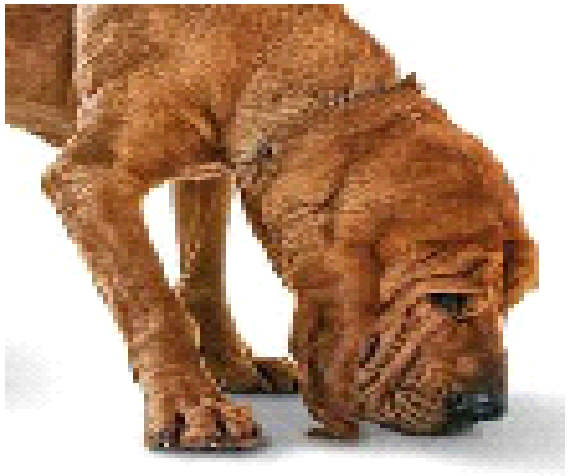
Following the Scent: Development of Canine Training Aids Guided by Measurements



Bill MacCrehan, Stephanie Moore, Michele Schantz

Chemical Sciences Division, NIST

Why do we care?

- Canines are sensitive, selective, mobile detectors
- Outperform portable instruments
- Canine evidence challenged effectively in court
- Lit et al “Handler beliefs affect scent detection dog outcomes”
- Supreme Court currently questioning canine evidence in two cases

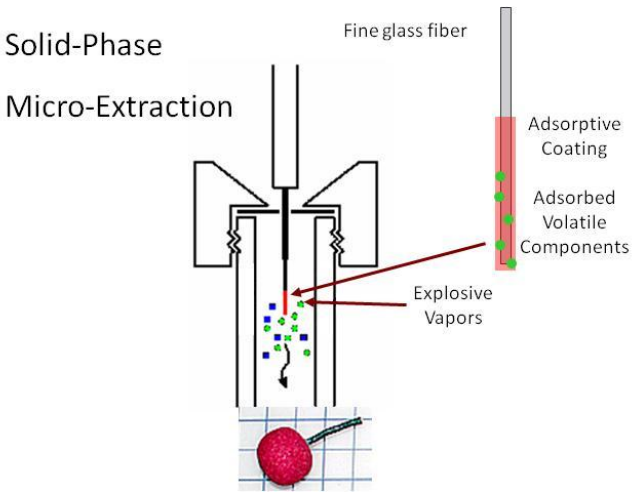
What can be done?

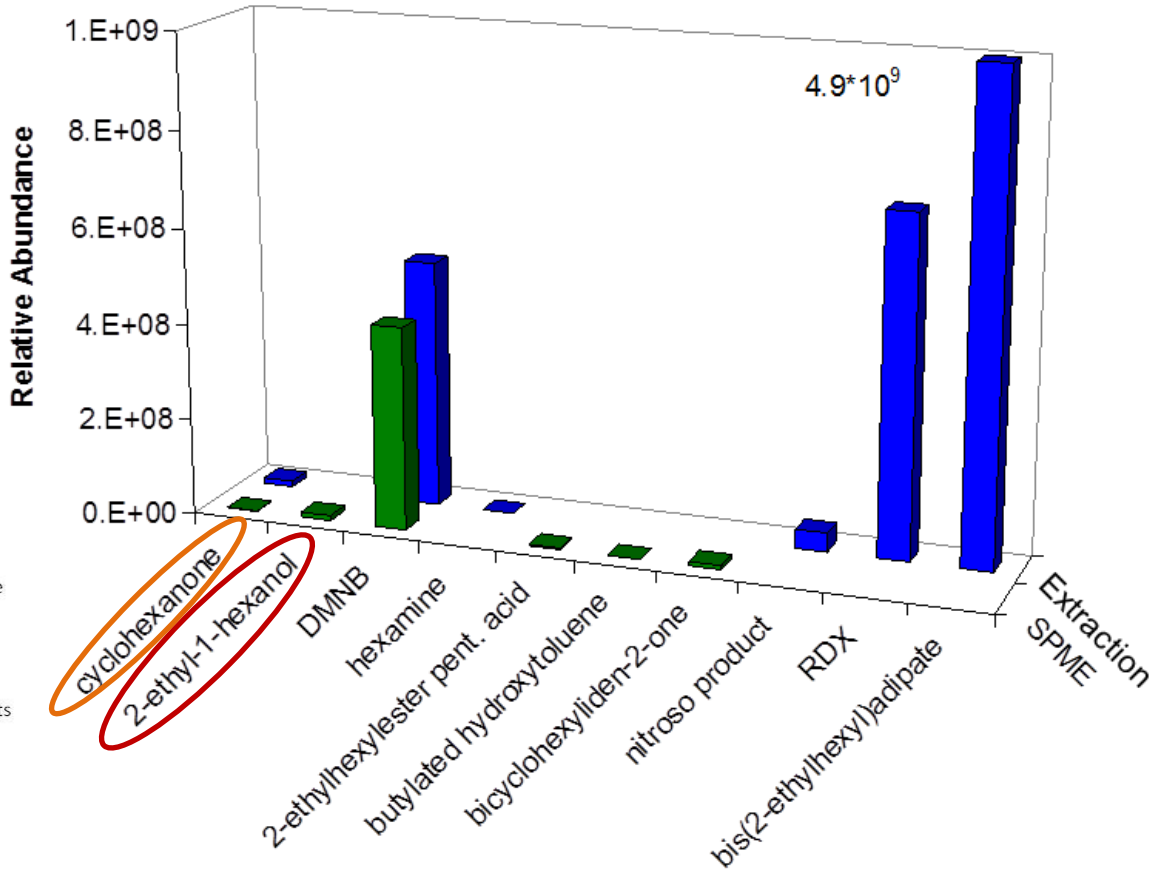
- Follow consensus training/certification “best practice” guidelines SWGDOG Scientific Working Group on Dog and Orthogonal detector Guidelines
- Need a uniform, validated set of training/testing materials with well characterized properties
- Costs of ***real*** controlled substances = high
- Costs of ***non-hazardous*** training aids = low

How did we start?

A "snapshot" in time of the volatile content using SPME

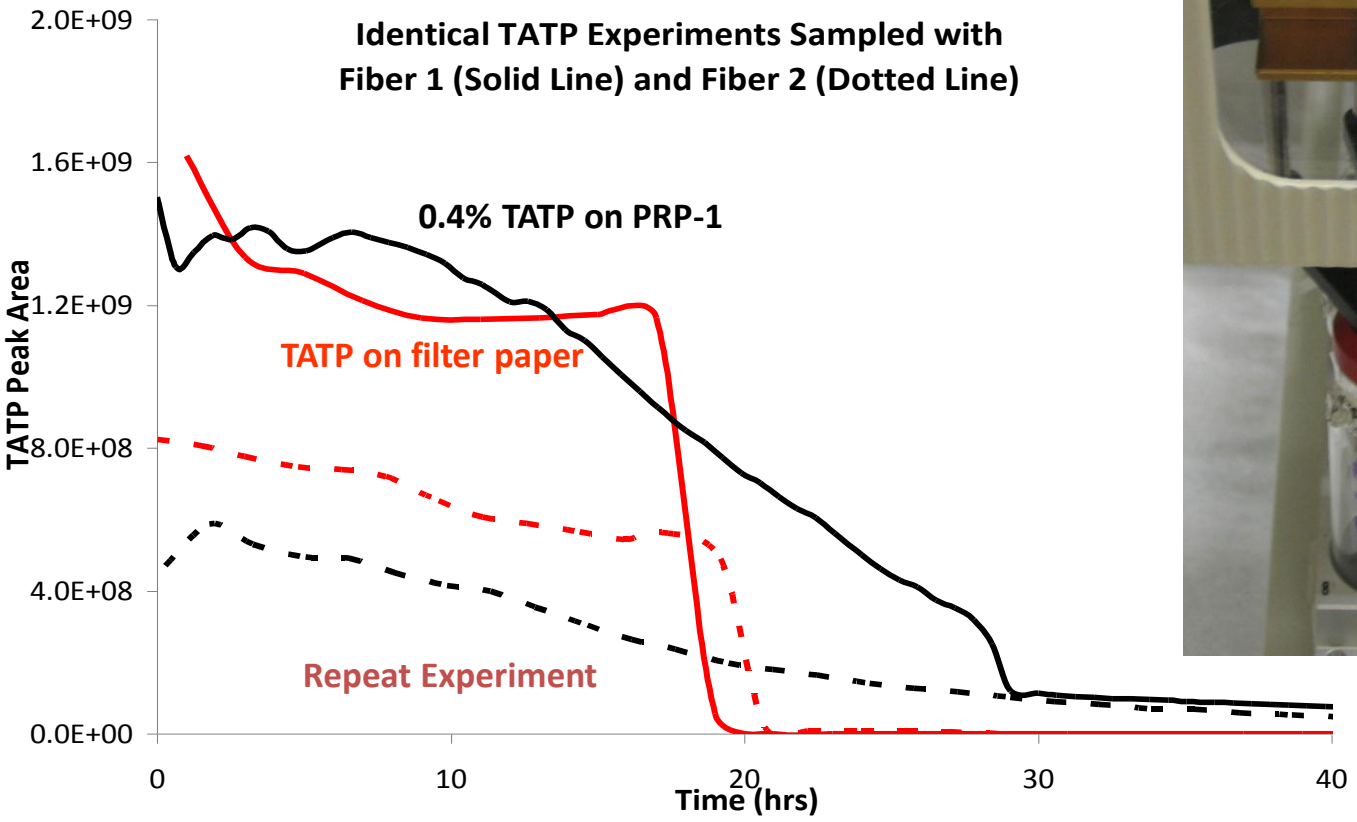
C-4 Non-volatile and Volatile Components





Characterizing Odor Release as a Function of Time with SPME

Vapor-time profile for TATP materials (1.4 mg) using direct, automated SPME

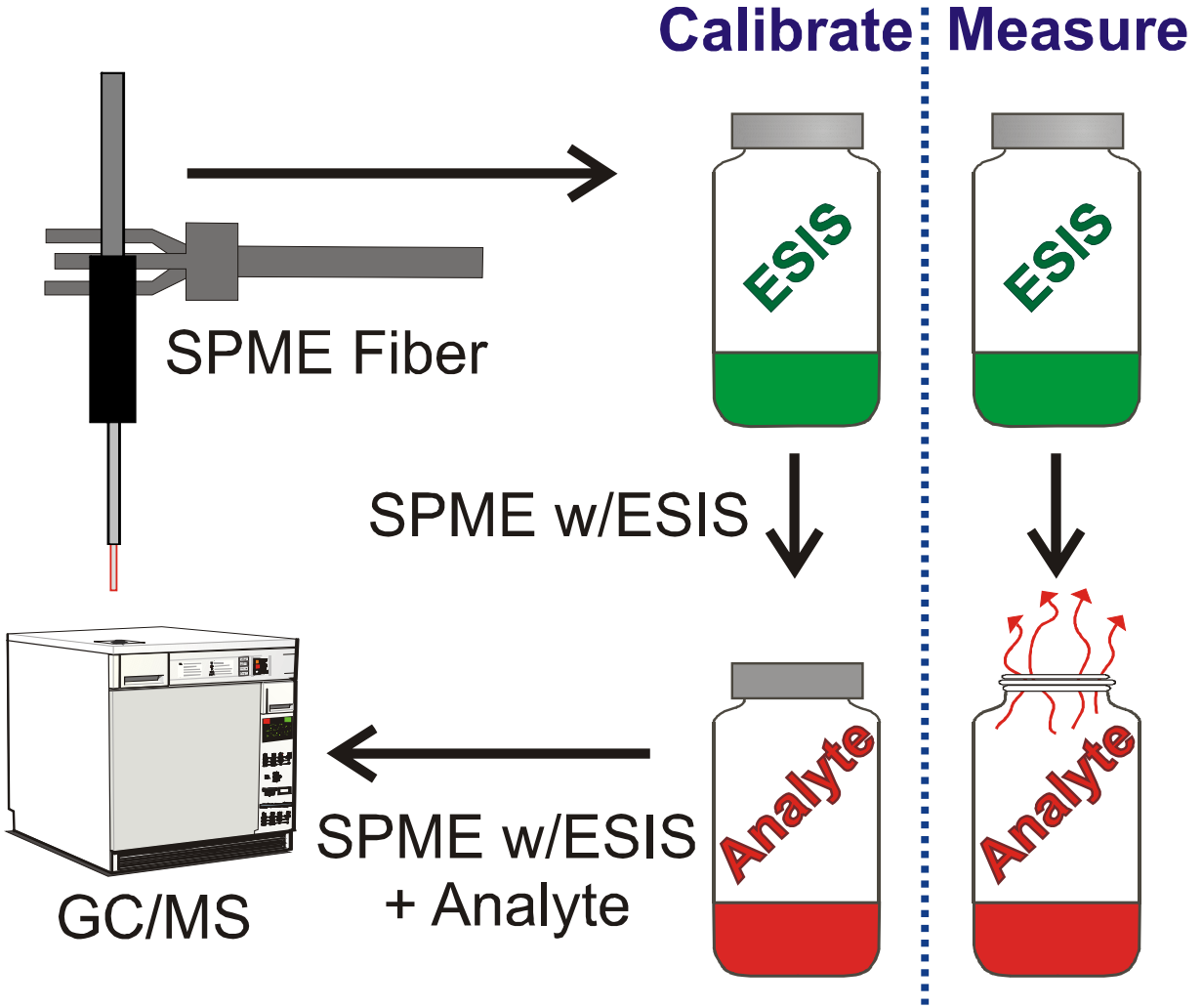


Moore, S., MacCrehan, W., Schantz, M., Evaluation of vapor profiles of explosives over time using ATASS (Automated Training Aid Simulation using SPME). Forensic Science International 212 (1-3); 90-95 (2011).

Characterizing volatiles in explosives as a function of time

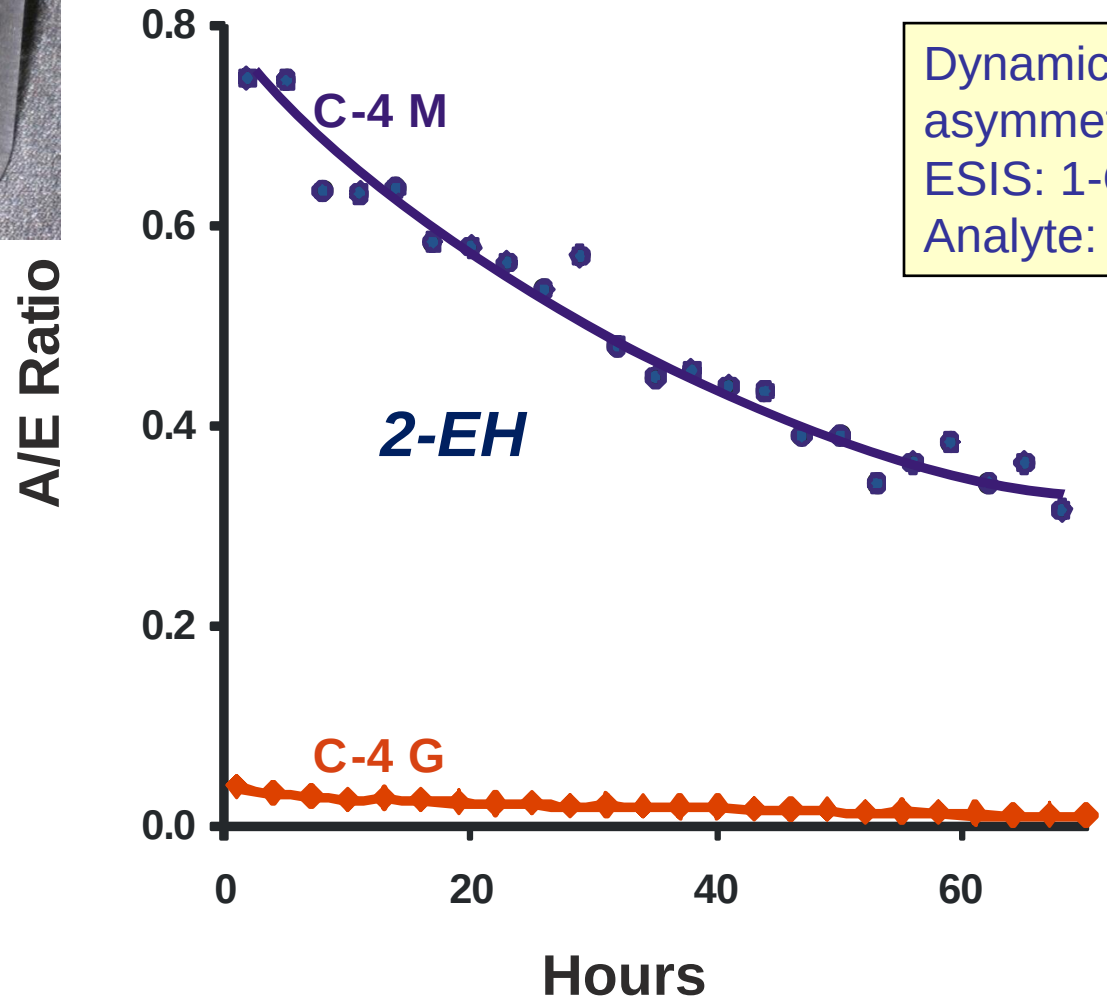
SPME with Externally-Sampled Internal Standard (SPME-ESIS)

Measure A/E ratio = Area Analyte/Area ESIS



1. WA MacCrehan, SM Moore, MM Schantz, Evaluating headspace component vapor-time profiles using solid-phase microextraction (SPME) with external sampling of an internal standard (ESIS), Anal. Chem., *83*, 8560 – 8565 (2011).
2. WA MacCrehan, SM Moore, MM Schantz, Reproducible vapor–time profiles using solid-phase microextraction with an externally sampled internal standard, J. Chromatog. A, *1244*, 28-36 (2012).

SPME-ESIS of C-4 Explosive for 2-EH (plastic explosive odorant)



Dynamic,
asymmetric sampling
ESIS: 1-Oct 6 s
Analyte: 2-EH 5 min

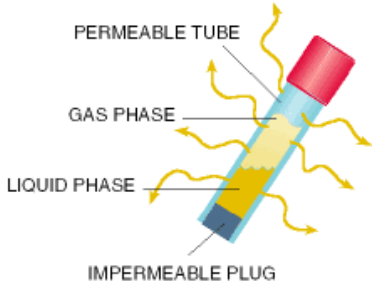
Training Aid Odor-Delivery Systems

Odorant laden particles

<u>Particle/vapor delivery</u>
- via fine particles loaded with odorant(s)

- trapped in the nose (not the lungs) and heated to 39 ^{o}C

Permeation Devices



<u>Permeation tube/bag delivery</u> (COMPS)
- vapor release by diffusion through container

Odorant infused polymer

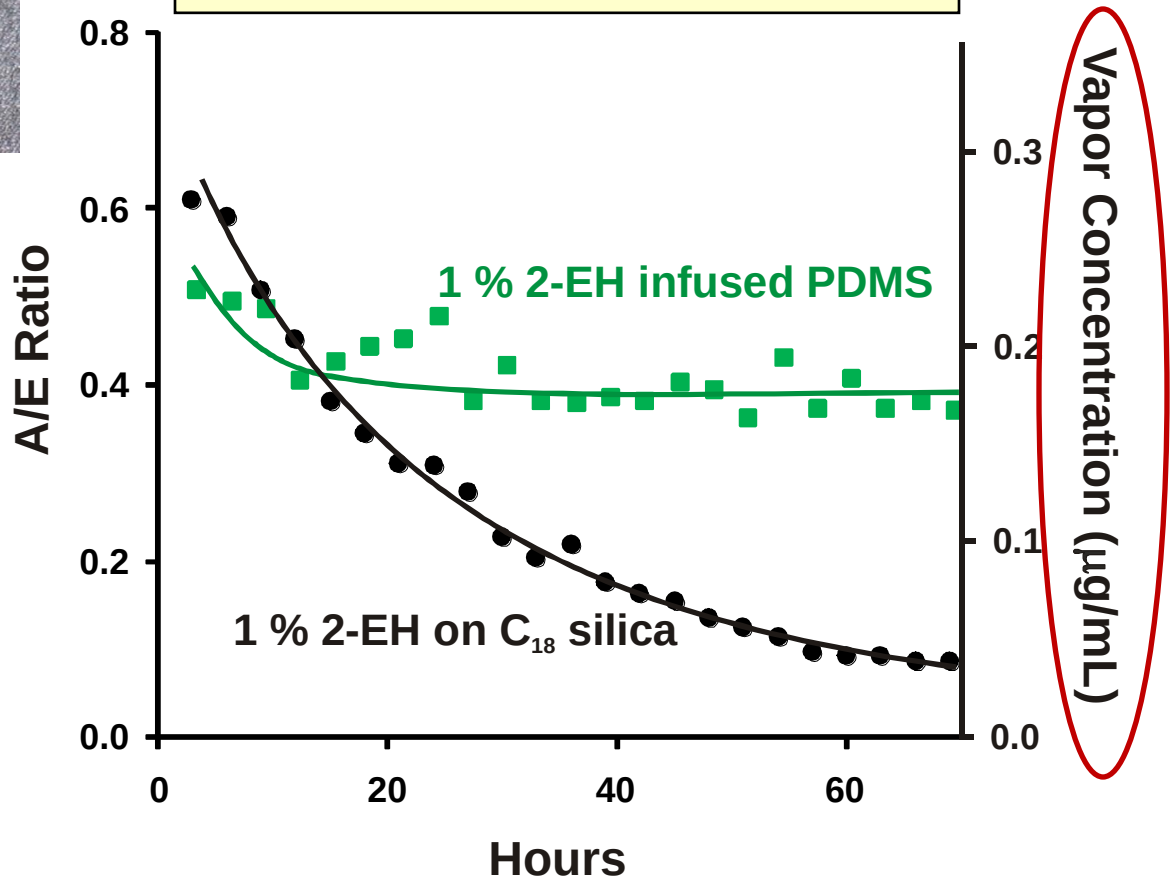
<u>Odorant(s) *infused* (3 ways) into PDMS</u>

- polydimethylsiloxane (PDMS), easily cast

- clear, like firm Jello

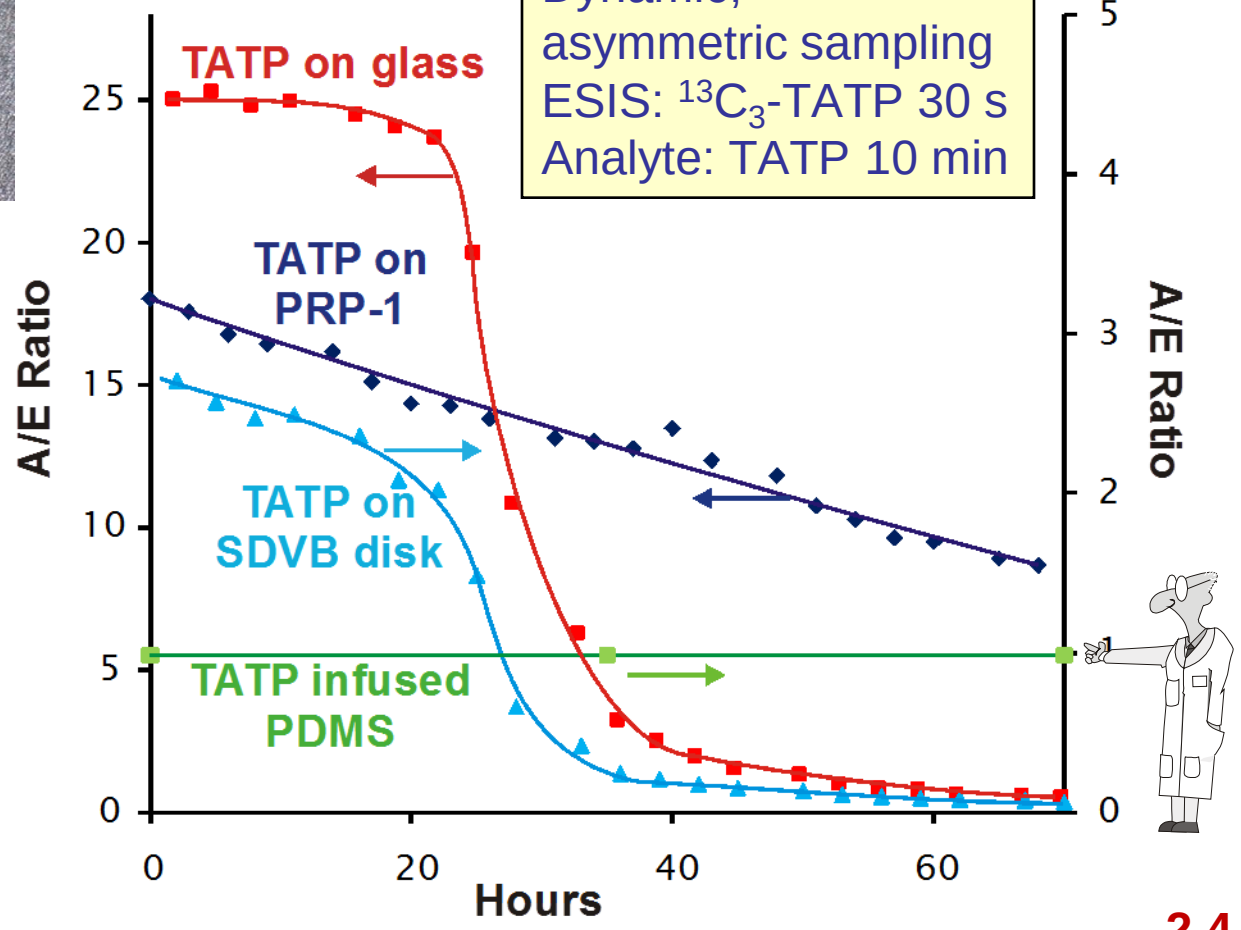
SPME-ESIS of Training Aids for 2-EH (plastic explosive odorant)

Dynamic, symmetric sampling 6 s
ESIS: 1-Oct; Analyte: 2-EH



SPME-ESIS of Training Aids for TATP

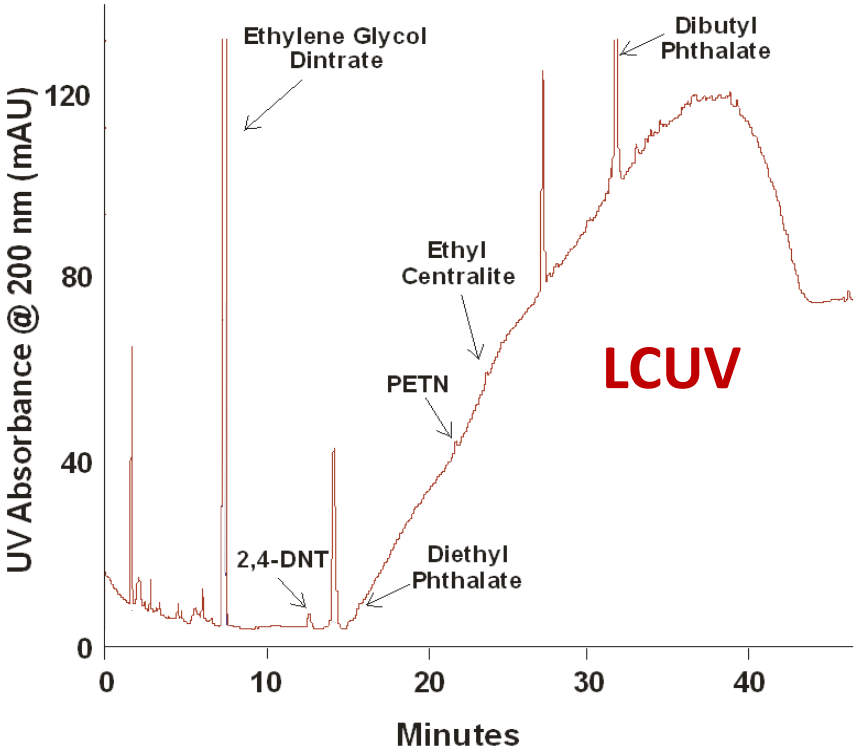
Dynamic,
asymmetric sampling
ESIS: $^{13}C_3$-TATP 30 s
Analyte: TATP 10 min



2,4-DNT too!

Infusing Vapor Components into PDMS

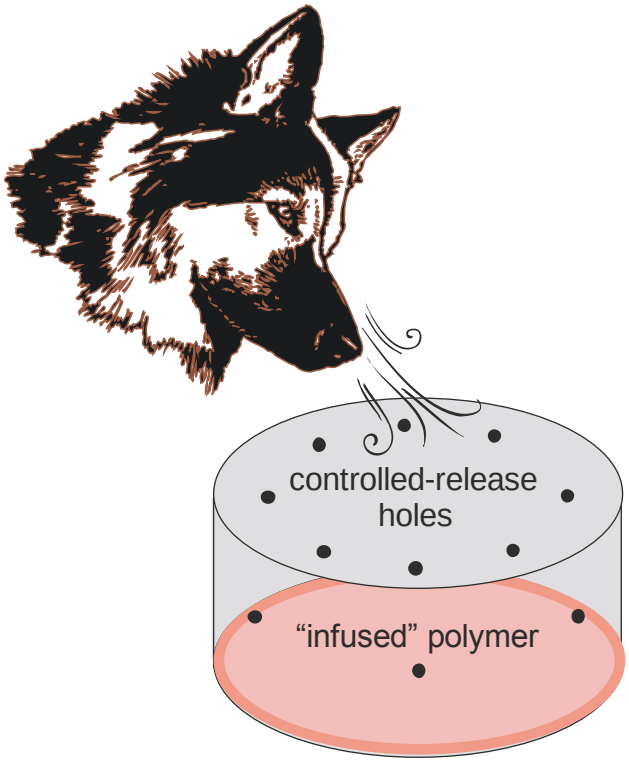
- ***Direct*** vapor infusion from complex hazardous substances, i.e., 3 types of ***Semtex*** **-** no *a priori* knowledge of composition required, i.e., marijuana



- Direct addition of vapor compound(s) to uncured polymer
- Absorbtion from solution of vapor compound

Renders hazardous substances safe to handle

Infused PDMS as a Canine Training Aid



Controlled-release vapor canister

Conclusions

- Canine detection is highly useful for a wide range of mobile detection needs provided accuracy can be validated

- Important role for ‘best practices’ consensus standards

- **Metrology can support development of technology for canine training aid development**

Homeland Security

Science and Technology

The Department of Homeland Security Science and Technology Directorate funded the production of the work presented in this material under HSHQDC-10-00297 with NIST.