Pacific Northwest
NATIONAL LABORATORY
Proudly Operated by Battelle Since 1965

Sampling Limitations for Trace

ADSA11

Eleventh Workshop for Advanced Development for Security Applications: Explosive Detection in Cargo for Aviation Security – Part II

David A. Atkinson, Ph.D.

Senior Research Scientist
Chemical / Biological / Explosives Threat Portfolio Manager
National Security Directorate
Pacific Northwest National Laboratory

November 5, 2014

“So what? Who cares?”

Pacific Northwest NATIONAL LABORATORY
Proudly Operated by Battelle Since 1965

[House Hearing, 111 Congress]
[From the U.S. Government Printing Office]

100 PERCENT AIR CARGO SCREENING: REMAINING STEPS TO SECURE PASSENGER AIRCRAFT

HEARING

before the

SUBCOMMITTEE ON TRANSPORTATION SECURITY
AND INFRASTRUCTURE PROTECTION

of the

COMMITTEE ON HOMELAND SECURITY
HOUSE OF REPRESENTATIVES

ONE HUNDRED ELEVENTH CONGRESS

SECOND SESSION

JUNE 30, 2010

Serial No. 111-73

Printed for the use of the Committee on Homeland Security

[GRAPHIC] [TIFF OMITTED] TONGRESS.#13

Available via the World Wide Web: http://www.gpo.gov/fdsys/

U.S. GOVERNMENT PRINTING OFFICE
64-699 WASHINGTON : 2010

- Anyone who flies on a commercial airplane
- Airline industry
- Freight industry

An air cargo solution has been implemented as mandated by Congress per 9/11 Commission Act of 2007 (9/11 Act) P.L. 110-53(2007).
The Certified Cargo Screening Program (CCSP) is a critical part of meeting this mandate. Cargo is screened at the piece level before consolidation for shipment.

BUT, what if a viable technology solution could screen palletized and containerized cargo quickly and efficiently?

This is not an easy problem

- Huge volumes of cargo are moved daily.
- The “just in time” aspect of air freight make the problem temporally difficult.
- Delays or additional handling have economic impact on the enterprise
- Cargo can have unpredictable shapes and sizes
- Imaging palletized and containerized cargo has issues with clutter and penetration

http://www.airpartner.com/Images/en-us/Freight/Home%20page/cargo-on-runway.jpg

Trace solution

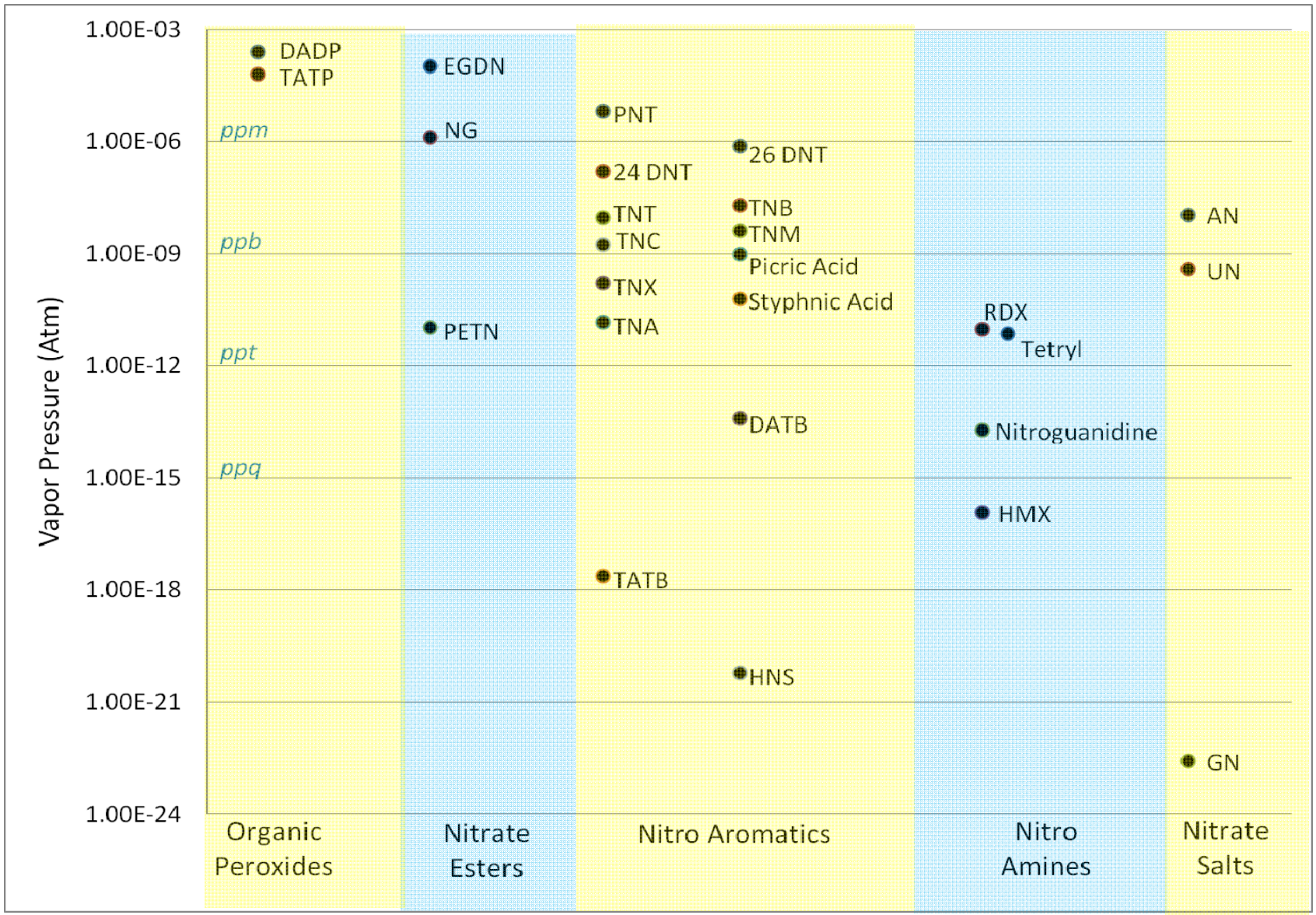
Trace detection can be an effective solution to consolidated cargo.

However, there are issues and limitations that need to be addressed:

- Vapor versus particle
- Sampling method
- CONOPS – time and access
- Detection limits
- Which detection signature?

http://www.tsa.gov/stakeholders/tsa-certified-canine-teams-effectively-detect-explosives-air-cargo

The vapor pressure issue



Ewing, Robert G., Melanie J. Waltman, David A. Atkinson, Jay W. Grate, and Peter J. Hotchkiss. "The vapor pressures of explosives." *TrAC Trends in Analytical Chemistry* 42, 35-48, 2013.

Vapor versus particle

Pacific Northwest NATIONAL LABORATORY
Proudly Operated by Battelle Since 1965

Realistically, collecting both would be optimal.

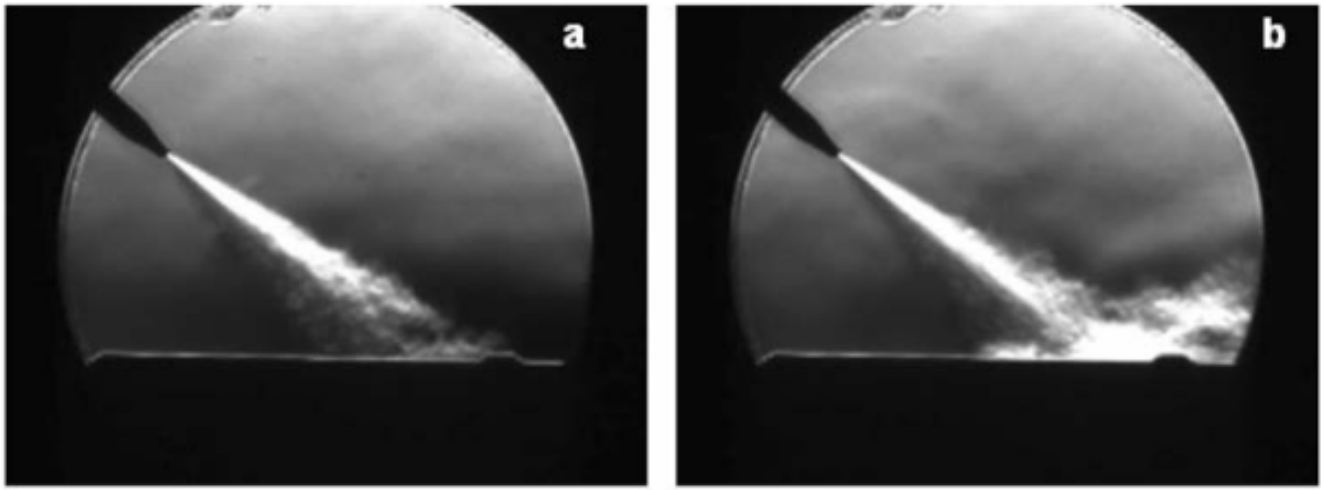
However, removing particles from surfaces AND transporting them across the inside of a cargo container space is difficult.

Aerosol Science and Technology, 42:1052–1061, 2008

ISSN: 0278-6826 print / 1521-7388 online
DOI: 10.1080/02786820802402237

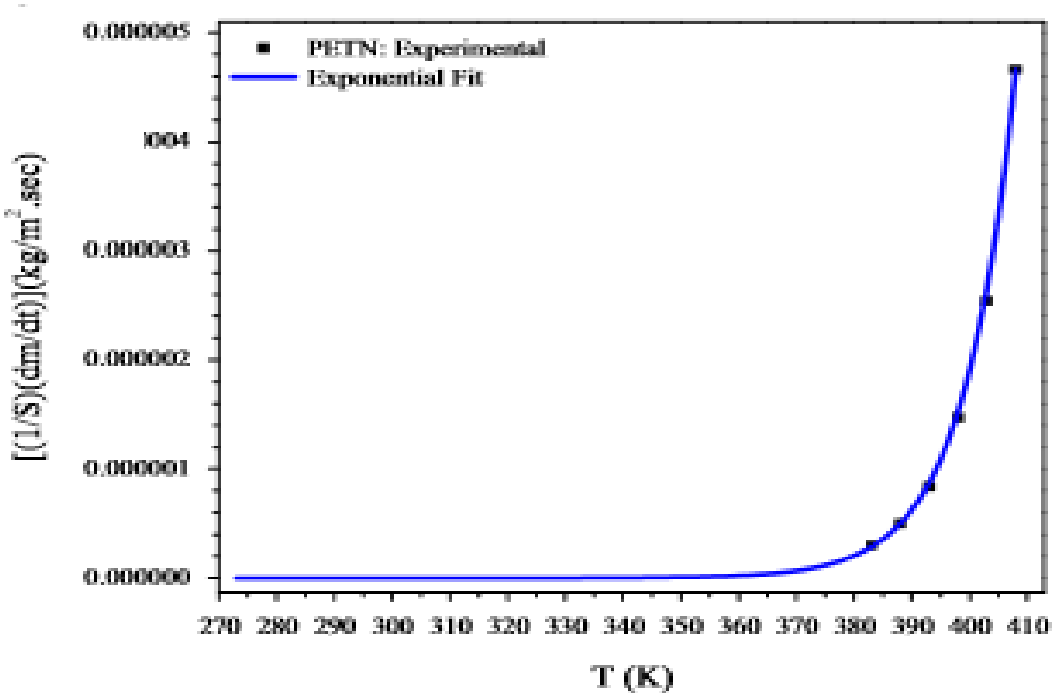
Measurements of Air Jet Removal Efficiencies of Spherical Particles from Cloth and Planar Surfaces

Robert Fletcher,[1] Nathanael Briggs,[1] Erin Ferguson,[2] and Greg Gillen[1]
[1]*National Institute of Standards and Technology, Gaithersburg, Maryland, USA*
[2]*Clemson University, Chemistry Department, Clemson, South Carolina, USA*

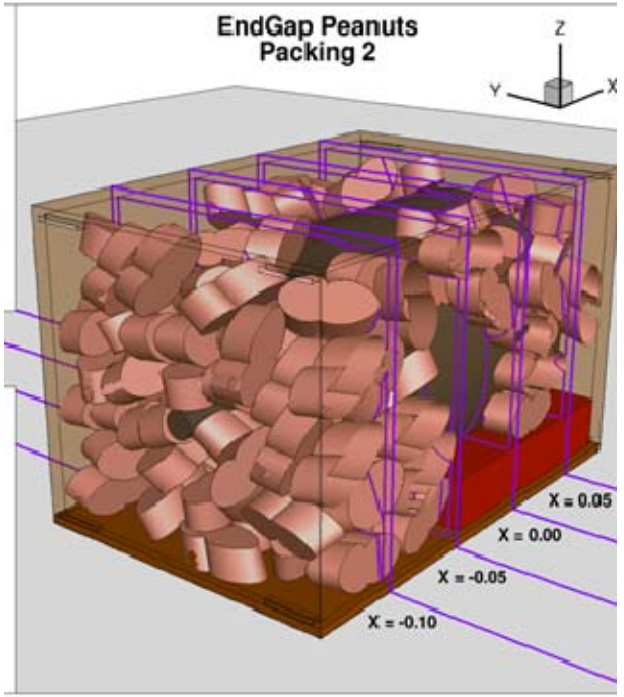


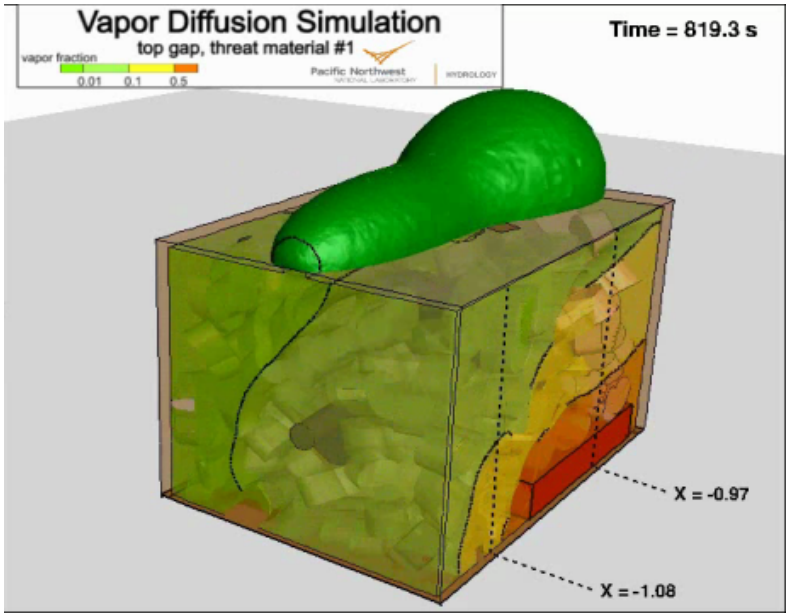
Vapor versus particle

Vapor collection not only has the vapor pressure issue, but also has a surface area issue, of both the explosive and the surrounding materials.



Hikal, Walid M., and Brandon L. Weeks. "Sublimation kinetics and diffusion coefficients of TNT, PETN, and RDX in air by thermogravimetry." *Talanta* 125 (2014): 24-28.





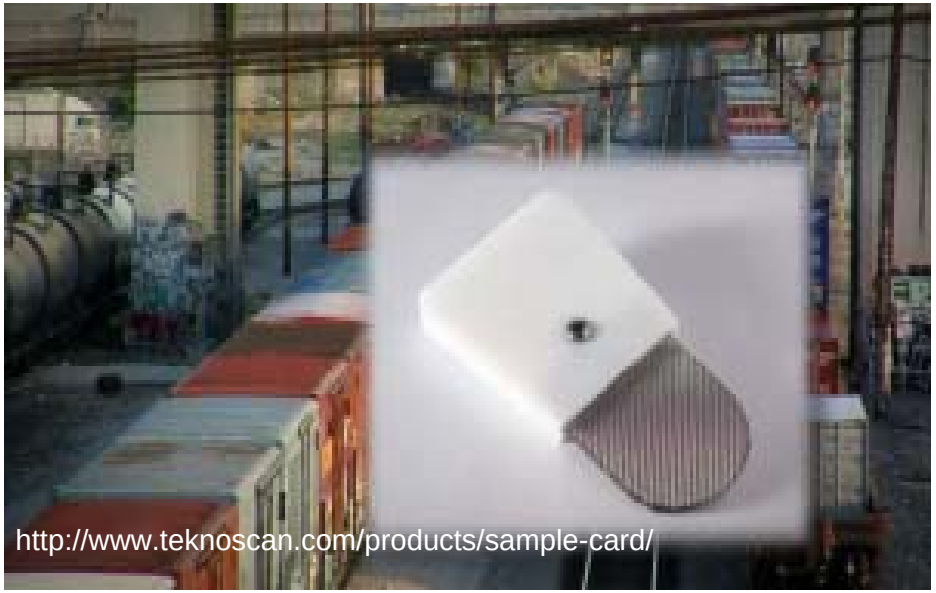
Vapor sampling

- Volume of sample needed (and thus time) is dependent on detection limits and preconcentrator efficiency
- Operational constraints such as time available per item and cargo configuration (container? shrink wrap? open pallet?) play a role in sampling approach
- Background issues?
- Analysis time versus sampling time (e.g. GC)
- Threats of interest (e.g. PETN vs. NG) will affect sampling parameters
- Sublimation enhancements such as heat, flash lamps, lasers

Commercial approaches - Teknoscan

Obviously, large volume will be needed unless a detection capability is revolutionary.

Large volume increases the probability of capturing a particle

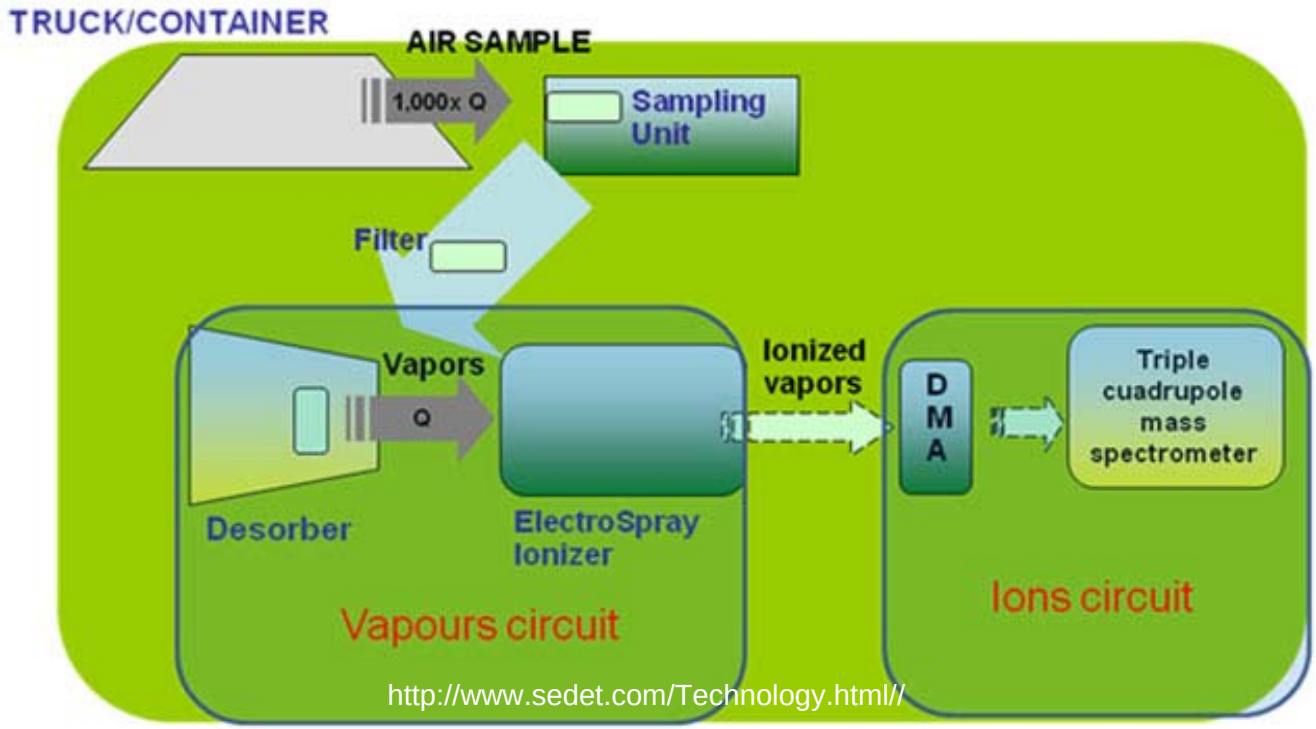


http://www.teknoscan.com/products/high-volume-aspiration-system//

Commercial approaches - Sedet

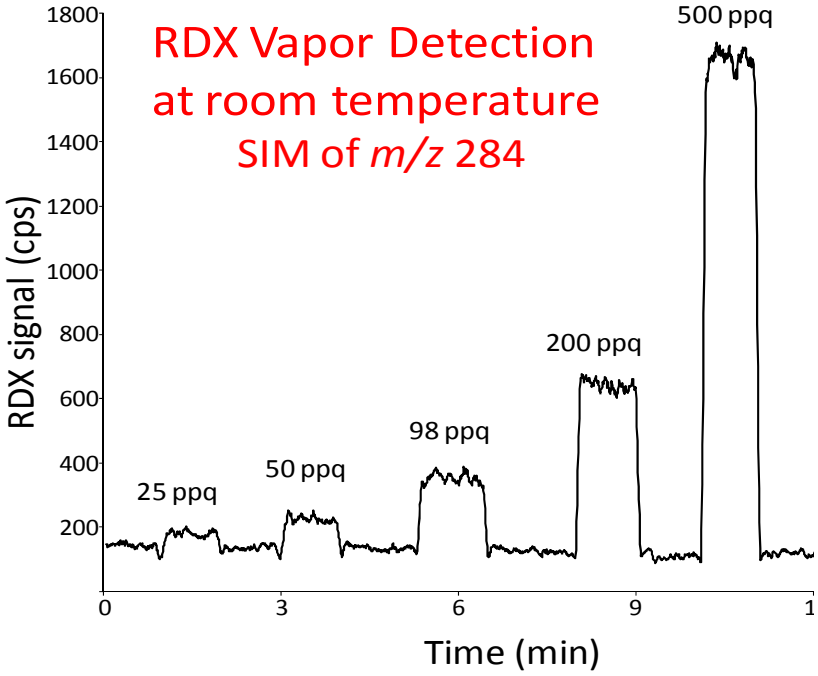
Using metal screens as high volume sampling preconcentrator is common.

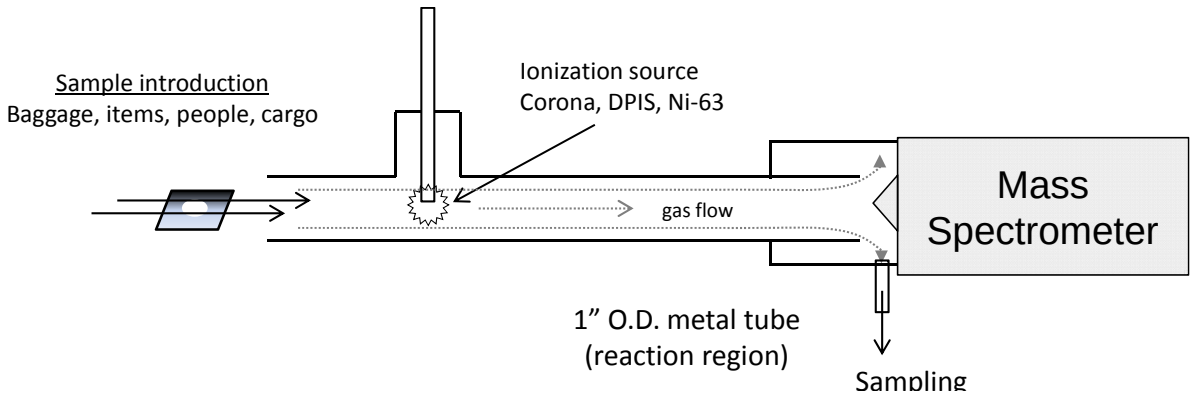
Differences in approach arise in the detection end point.

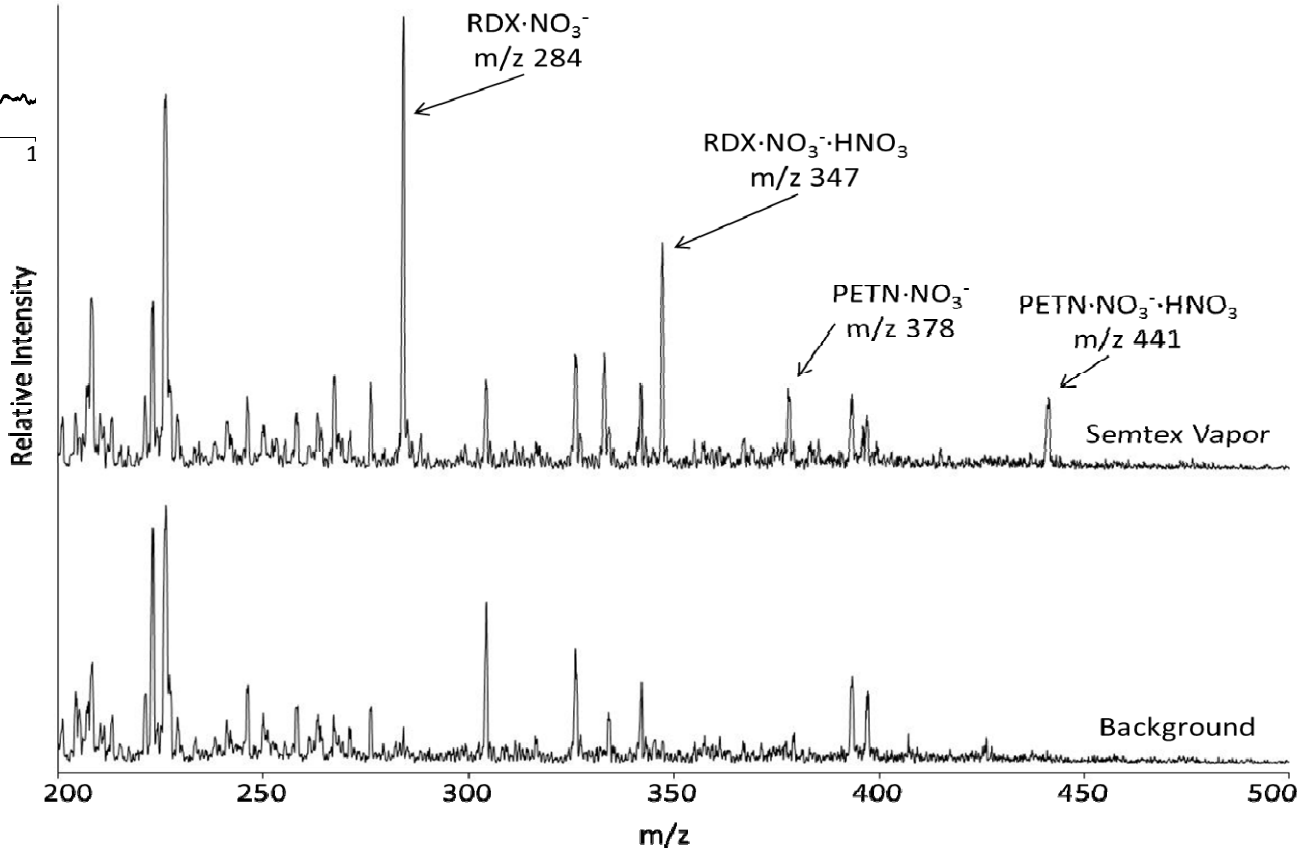


PNNL vapor detection technology

Pacific Northwest NATIONAL LABORATORY
Proudly Operated by Battelle Since 1965

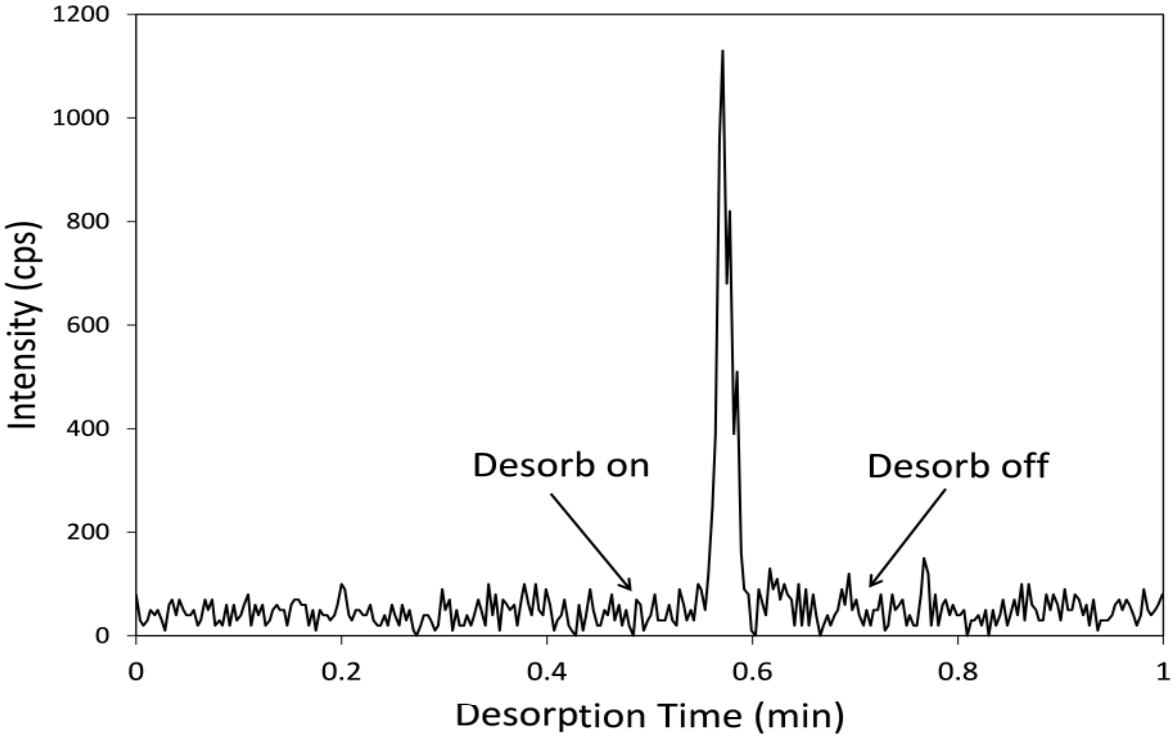






Vapor from mass in cargo container

- Sampled air from within a cargo container with 2 closed explosives magazines that contain a variety of explosives including RDX and C-4
- Sampled for 5 min at ~ 20 L/min onto a wire filament
- Sample was analyzed by the AFT-MS
- Estimated concentrations within the cargo container ~ 10-50 ppq



Cargo Container

High-speed desorption sampling tubes

Summary

- Direct trace analysis of consolidated cargo is an attractive approach
- If detection limits do not allow for direct, real time detection (e.g. canines), then sampling will be a critical step
- Cargo configurations are widely variable, leading to difficulties in sampling methods
- Preconcentration must be robust, efficient, operationally suitable, and efficient
- Detection limits are important!
- Backgrounds and environment need to be considered
- It’s all about surfaces